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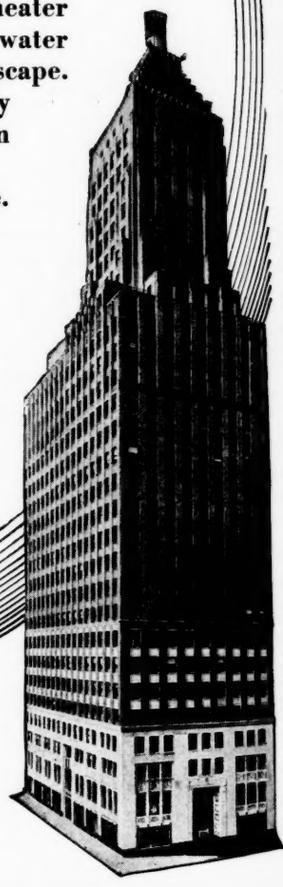

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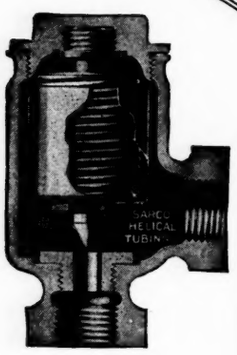

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EDITORIALS

At the Crossroads

EXCEPT for sound picture apparatus nothing in connection with theater buildings has received more general acceptance in recent years than has the air conditioning. The statement seems true in spite of the progress made in interior designs and decoration, in lighting, seating and mechanical devices for the stage.

As a result of the acceptance of air cooling some progress has been made in equipping theaters for conditioning. In spite of the progress, however, only a small fraction of existing theaters are now conditioned.

The adoption of conditioning by theaters, gratifying as it may be, is not the only point that should be remembered. We must not lose sight of the fact that the theater has been one of the most important places where the public has come in contact with the idea of air cooling in summer. If the use of artificial cooling becomes general, the theater installations can be thanked at least for speeding the acceptance. The favorable reaction of the public furnishes the best evidence that theater plants have been successful in operation. It is equally true that poor plants or poor operation will create correspondingly bad impressions.

The intimate contact with the public may prove to be either a great blessing to air conditioning in general or it may result in a total loss of faith, depending on the success of the plants now being installed or which may soon appear. The industry cannot afford to let any theater plants fail, for the public is likely to be critical.

Drives for reduced costs, both first and initial, are certainly becoming more and more intense, and there seems to be a tendency to sacrifice quality for price. This must not be carried too far, and it easily can be. If reduced costs must be secured they should be accomplished by new developments or by better operation—not by skimping and cheapening the plant.

Much can still be done in improving operation. The most desirable conditions are as yet by no means established nor are the limits of operation clearly defined. Instead of cheapened, border-line plants, what is needed are plants with enough reserve and flexibility to permit field study to determine what can be accomplished and where the operating limits lie. Such plants, however, cannot be expected until there is an enlightened management, no matter how earnestly engineers desire them.

•

A Change of Opinion

FOR the past seven or eight years we have heard the opinion of the oil burner merchandisers that those people in a given locality who had installed gas-fired heating equipment are the best possible prospects for oil burners. The idea is that after perusing his December and January gas bills the customer will be in such a state of mind that he can scarcely wait to change over to oil.

On the other hand, some gas advocates have been under the impression that any home owner who bought an oil burner should immediately be placed on the gas company's prospect list, the idea in this case being that after any of the dire things which competitors like to think will happen to oil burners do happen, all the gas man has to do is make a casual call and a new customer will be added to his list.

At least one of these ideas must be more or less mistaken, and at best one is now on its way to the storehouse. The report of the house-heating committee of the American Gas Association for 1931 contains the unexpected statement that "the majority of the people who use other fuels than gas are entirely satisfied with what they have," and "over a period of years less than 15% of one of the most aggressive gas companies have replaced oil, and this percentage is decreasing rather than increasing."

The committee is to be commended for its courage in daring to frankly state what it has found to be true. It will be interesting to see what the actual results along these lines have been with the oil burner industry.

•

Insulation in House Cooling

MUCH has been said and written about what is ultimately to be the form of the residential heating and cooling plant. Many have looked into the future and brought forth their ideas. Naturally, the ideas differ widely. All the prognosticators are agreed that air cooling during the warmer months is logical and that it can be expected as a major development in the rather near future.

The differences between the views of the prophets as to how this cooling is to be accomplished, the degree of cooling necessary, and as to how long during the season such cooling will be practiced, add zest to the predictions. Some see power cooling units of low cost as being the solution and have predicated this conclusion upon the assumption that such units are necessary. Others point to the possibilities in the use of ice in some localities. That cool city water, where available, can be used is self evident. The possibilities in the use of naturally cooled night air for the purpose have been but little mentioned by predictions, but are worth consideration.

One of the notable facts in connection with making predictions as to what will happen is that no sooner does one predicter satisfy himself that he has arrived at the ultimate solution than a new bit of information comes along to confound the conclusions.

Recently, the gas interests caused cooling installations to be made in two houses. One of these houses was insulated during the course of the summer. In the

words of the paper reporting the results of the operation of this plant ". . . . thereafter there were only four days when the temperature and humidity in the house were such that operation was necessary."

This point, while merely an isolated fact, may have more significance than is at first apparent. If the insulation of the house resulted in making it necessary to operate a cooling and dehumidifying plant for only so short a period, is it not possible that, if full advantage were taken of naturally cooled night air circulated through the building automatically during the cool night hours, very little artificial cooling during the hot hours of the day would be necessary? In other words, insulation of the building might make the period of use of artificial cooling so short that elaborate apparatus for the purpose would scarcely be justified. Certainly this would not be true in all localities or in all climates, nor would full control of the conditions be practicable. At any rate it is an interesting question and one deserving fuller study than it has received.

The possibility of such a small observation bringing about changes in practices merely goes to illustrate how little we still know about the whole problem of living-space cooling, and that predictions are necessarily based on meager facts.

•

The Home Loan Bank Proposal

THE President's proposal of a system of home loan banks as announced last month is the first tangible evidence of actual detailed recommendations from the several conferences on housing and related building activities. It must still be approved by Congress before it can become effective. This will take time, and furthermore, there is no predicting in what form the final law will appear. Those close to the subject seem to feel that the proposal outlined is basically sound.

Except in a few localities home construction has almost stopped. The total for the year is estimated at not more than half the amount required to take care of normal population growth. As a result, an accumulated deficit is being built up. Material prices are now lower than for some years. If now credit can be made available the combination of factors should lead to real activity in home construction. This, together with the public building program, will bring a volume of business which again will place the building industry in a favorable position.

•

Processed Air for Industrial Employees

RECENT months have brought about a situation in which installations of processed air are either now being made, or are projected in classes of buildings which heretofore looked with disfavor upon its use. Whereas such air has been until now largely confined to industrial plants and processes, and to theatres and department stores, other commercial buildings, including both offices and factories, are showing a considerable inclination at least to experiment with it.

This new-found interest is notable especially in that, in at least several of these installations, the managements appear to be making the move wholly from the standpoint of the effect of the air upon the comfort and health of employees. This is rather distinctly a new departure.

When processed air is used as a part of a manufacturing procedure the return is somewhat tangible in terms of decreased spoilage, higher or more uniform quality, increase in annual operating time, or similar items. Much the same is true where installations are made for the benefit of customers, as in theatres, department stores, or rented offices where the return is roughly measurable in terms of increased sales or patronage, or of greater renting appeal.

Since industrial operations are competitive and commercial, it is scarcely to be expected that the investments required for providing processed air for employees are being made, or are likely to be made in any great volume in the future unless they can be shown to produce a satisfactory return.

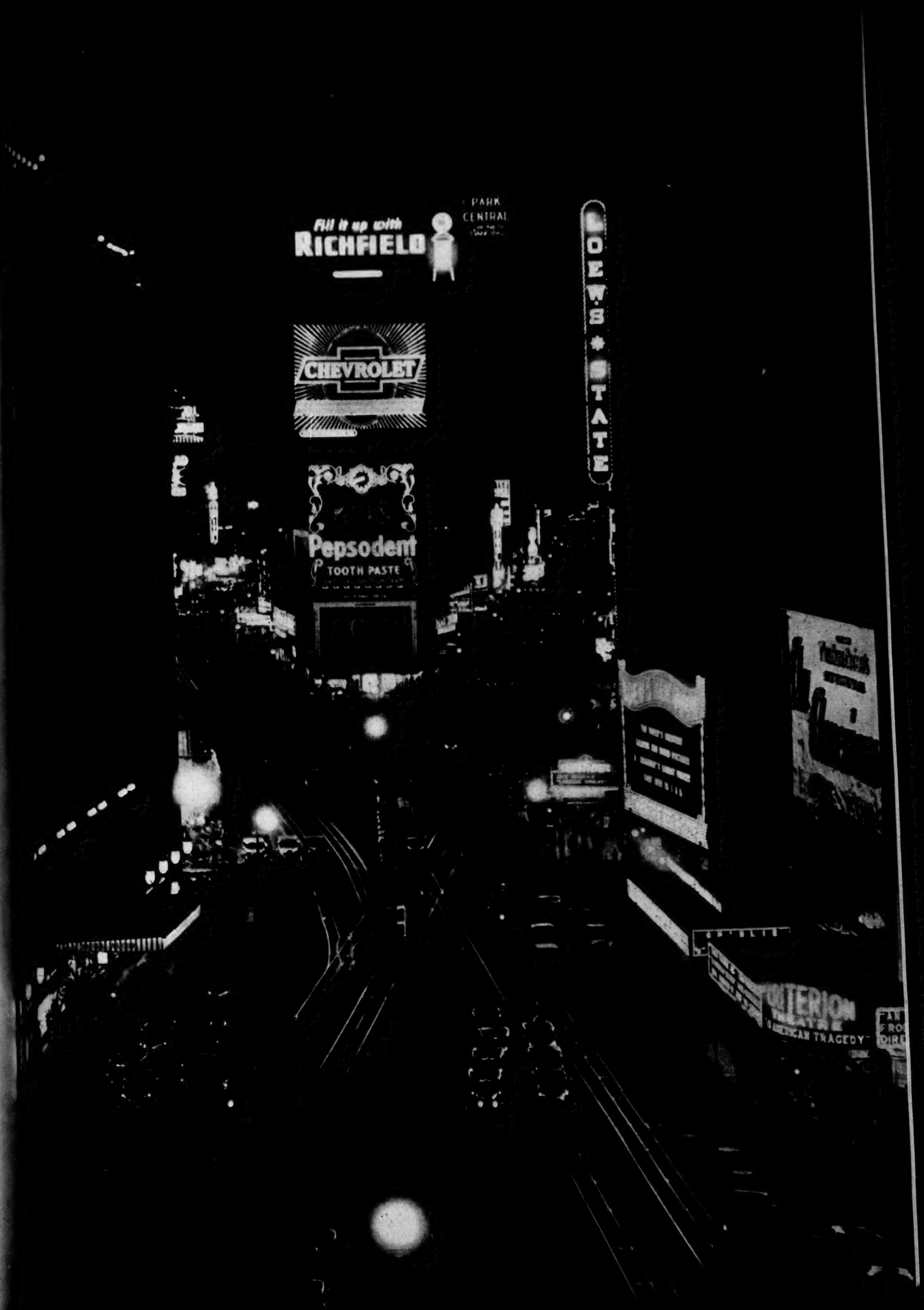
Two interesting points arise in this connection. One is that at present there is almost no information readily available and in convincing and unmistakable terms showing whether or not such a return can be realized. The second is that the factors involved in the return are not only indefinite and nowhere clearly stated but are likely to prove rather intangible in nature.

Just how can a management expect to secure a return on an investment made for the benefit of its employees?

It would seem that the return might be expected in much the same way that one is secured from other similar investments, such as health and accident insurance funds, pensions, home-building aids, and all the other so-called welfare work into which commercial managements have long placed investments. Looked at in this way an air conditioning plant may be considered as a part of welfare work. If and when it is so regarded, managements have more precedent for making the investment than would appear at first sight.

It is to be hoped, though, that a more tangible basis may be found in terms of which the advisability of using processed air industrially and commercially may be demonstrated. Unless this is done, the application are likely to be confined to plants where management are sympathetic to welfare work. Unfortunately, long experience has shown that by no means all are inclined.

On the other hand, if the use of processed air could be shown to be definitely profitable, practically every industrial and commercial plant could be regarded as an ultimate prospect. Now that there is likelihood of some of these installations being made, it is certainly to be hoped that an enlightened management will be found which will thoroughly study the operation of the plant and produce data showing full operating and investment costs and the return in terms of at least those factors which can be definitely credited to it, such as the decrease in sickness absenteeism, the reduction in turnover, and any increase in units of product per man-hour. Collection and publication of such results by a disinterested party would be a boon to industry applications of air conditioning for employee comfort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Air Conditioning Design for Theaters‡

By M. G. HARBULA†

IN this article the author has attempted to classify and arrange theaters into three general groups, (a) the de luxe, or large theater, (b) the neighborhood or medium-size house, and (c) the small theater.

De Luxe Theaters

De luxe, or first run, motion picture houses are usually located in the downtown sections of large cities. This type is expensive and elaborate. A few years ago such theaters were often constructed as memorials to the owners or exhibitor. No expense was spared. Art objects were often purchased and paintings with values as high as $50,000 were hung in the elaborate foyers, grand halls and lobbies. Rugs in some instances cost the owners as much as $75,000.

The architecture followed some period, such as early French, Italian or Spanish. More recently there has been a decided trend toward Moorish, Chinese and other Oriental treatments.

The open air sky effect was introduced and adapted to the theaters following Oriental design. In these a garden and open sky effect was created by building false parapet walls inside the regular building walls, with lights used to produce an effect of distance. Ceilings were often of flat plaster suspended and decorated to resemble the open sky. Colors and lights were used to represent stars. In these theaters the large lighted domes, which formed much of the ceiling in the period house, and the ornate boxes were omitted. All these features helped to make the air distributing system simpler and less expensive.

The larger de luxe theater is provided with a multitude of rooms for the services which are part of such establishments. Dressing rooms for artists range from the star's quarters with lounging room and private bath to the smaller rooms for the other players. Fully equipped kitchens and laundries are not uncommon. They are equipped with ventilating plants for the toilets and with radiators for direct heating.

The stage itself is equipped with direct radiators located in tiers on the back walls. The stage carpenter, house electricians, operating engineers, cleaners and sign painter are often provided with separate rooms in the basement. Ushers are accommodated in basements or on the mezzanine levels in spaces built into the balcony plenum chamber. The basement also accommodates, or should accommodate, most of the operating machinery. Space under the orchestra may or may not be excavated. In the older houses it almost always was excavated, but the policy in newer theaters is to excavate only sufficiently to allow for construction of narrow tunnels which serve as air ducts for the return, exhaust or supply of air depending upon whether an upward or downward supply is used.

Offices for the managers, for which cooled air is usually desired, are often located off the lobbies, sometimes on the mezzanine levels.

Basement rooms are provided with mechanical ventilation and with either indirect heating or direct radiators. One or two individual systems are used, depending upon how the rooms can be grouped. Separately valved steam lines are run to the indirect heating stacks and to the main supplying the radiators. This is done in order to furnish heat to the several groups of rooms occupied by the different services at different times. Ushers' rooms usually have separate heating and ventilating plants arranged in like fashion. The service rooms, including dressing rooms, usually are not provided with cool air.

Patrons' lounges, rest rooms, smoking rooms and toilets are often located in the basement. In the larger houses there may be two sets of these, one in the basement or off the lobbies, the other on one of the mezzanine levels. Their ventilating plants are usually separate from the service rooms or auditorium. Direct radiation is frequently used. The air supply in the older houses came direct from the outside, while in those built recently, these rooms are equipped with exhaust systems only, the supply being drawn from the adjoining spaces. With this arrangement, a moderate degree of cooling is available in these rooms for the return air from the auditorium is considerably cooler than the outdoor air. The principal objection to this practice is that the used air from the auditorium carries with it the attendant odors always emanating from a peopled space. Frequently, this necessitates placing a chemical in these rooms for neutralizing the odors.

Recent practice contemplates supplying air from the main plant direct to the lounges and rest rooms, the exhaust for the toilets drawing its air from these rooms and discharging it to the outside. Sufficient air is made

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† Consulting Air Conditioning Engineer, Glen Ellyn, Ill.

available for the greater number of air changes required for the toilets.

Whether the air supply for the public rooms is drawn from the theater or taken direct from the main air source, the amount of refrigeration effect required to cool these rooms in summer is identical, since air discharged through the toilet exhaust must come from the outside initially and this adds to the cooling load the proportionate amount of outside air taken into the plant to balance the loss through these rooms to the atmosphere.

Projection rooms are always provided with separate ventilating plants and usually are equipped with direct radiation for heating. Ventilation requirements are dictated by existing local regulations and the requirements of the projection equipment. Many are kept comfortably cool by a supply of cold air direct from the main auditorium supply in the adjoining theater attic. The air supply and exhaust systems for these rooms should balance as to quantity of air circulated to prevent air being drawn through the projection apertures in the walls of the booths, otherwise, damage in the form of cracked lenses may result.

Neighborhood Theaters

Neighborhood houses are built in local shopping centers of outlying residential sections. These are usually very simple structures, designed with the main idea of getting as many seats as possible within four walls. Architectural treatment is usually plain. The open sky effect is popular in recently constructed neighborhood houses, due to low construction costs.

Some are equipped for vaudeville and stage shows, but the majority are not. Those not equipped for stage shows have their projection screen built practically on the back wall. A fully equipped stage with its "props" adds materially to the cubage of the structure and increases the cost.

Few auxiliary rooms are provided. Dressing rooms for artists are included only when there is a stage and then they are usually small. A handy man usually maintains the building in general repair. The manager is provided with an office. Public rooms consist of toilets only in many of these houses. Some have a general lounge for ladies and men. These are usually located where the windows open to the outside air and natural ventilation is used.

This type of theater is often combined in a structure housing stores, offices and apartments.

Heating and ventilating plants as a general rule are mediocre in character. In many the only mechanical ventilation other than that for the auditorium is in the projection booth, and this because as a rule local ordinances prescribe it. Heating of the auditorium is practically always by the indirect method in connection with the ventilating plant. Steam is commonly used because direct radiation in other parts of the structure must be served. Where the building is for theater purposes only, direct-fired air heaters with either oil, coal or gas as fuel, and used in connection with the ventilating equipment, are sometimes used.

Cooling plants have been adapted to a few of these houses in the larger cities during the past five or six years. About 75% of the cooling plants, using ice as the cooling medium, have been installed in this type of house in the past two years.

Small Theaters

The next general type of theater is the small house seating from 100 to 1000 people. These include older theaters in downtown districts, as well as the smaller neighborhood houses and small town theaters which may have an evening show daily with two shows or one continuous show on Saturday and Sunday; others may be open but two or three times a week.

These small houses are plain and simple structures. Patron accommodations beyond the seats are scanty and limited. Heating and ventilating equipment is rather crude in many. Some belonging to the larger circuits are well equipped, and in the past year or two there has been a trend toward installing cooling plants in some, using ice as the cooling agent. Some are equipped with plants consisting of a fan supplying a large volume of air, in some instances as much as 50 cu. ft. of air per min. per seat. This air is introduced usually through large grilles on each side of the proscenium arch or just above it and is exhausted at the rear of the house. Air washers using recirculated water are sometimes added or installed. While reducing the sensible heat of the air this practice increases the relative humidity proportionally, thus creating an effect of cooling though in reality it is psychological only, no actual cooling being produced. Cooling plants using mechanical refrigeration have not been used to any extent in houses of this size and type, largely because of the high cost. In some cases where owners obtained estimates they found that it amounted to more than 50% of the cost of the entire building. This type of theater offers perhaps the most fertile field for cooling plants equipped for the use of manufactured ice as the cooling agent.

A FEW FACTS REGARDING THE MOTION PICTURE INDUSTRY

Total investment	**$2,000,000,000**
Weekly attendance	**110,000,000**
Weekly New York attendance	**5,000,000**
Number of theaters, about	**20,000**
Theaters wired for sound, about	**12,000**
Air cooled theaters (total), about	**300**
Air cooled theaters (ice), about	**20**
Probable potential market for theater cooling plants	**3,000**

Turnstile Theaters

Under the classification of small theaters may be included the new turnstile theaters of which several have been built within the last two years. This type of small house is a very elaborate miniature theater. The appointments are rich, and they have a cozy atmosphere. Modernistic architecture predominates in those already

General Data Pertaining to Various Classes of Motion Picture Theaters

(Classified for Purposes of this Article only. Numbers Indicate Tendencies, not Actual Limits which Necessarily Vary)

	TYPE			
	De Luxe	Neighborhood	Small	Turnstile
Capacity	2000–5000	1000–2500	100–1000	200–400
Hours	From 10 a.m. or 1 p.m. to 11 p.m.	1 p.m. to 5 p.m. 6.30 p.m. to 11 p.m.	Continuous from noon to 11 p.m.	Continuous from 11 a.m. to 11 p.m.
Program	Feature pictures, comedies and news reels; usually stage shows and vaudeville also	Feature pictures, comedies and news reels; some have stage shows	Late runs of pictures with newsreel or comedy; occasionally run two feature pictures for same admission	Newsreels, travelogues, educational, comedies
Admission	Before 6 p.m., 15c to 50c; evenings 75c to $1, or more	10c to 35c for matinee; 20c to 50c for evening	5c to 25c	25c

built. The seats are all on one level. They are built in spaces formerly occupied by retail stores and are usually long and cubical in shape with comparatively low ceiling height. False pitched floors are sometimes built over the existing floors. This type of theater and method of showing motion pictures is a comparatively new idea and its future cannot be forecast. The operating and service personnel is reduced to a minimum and, consequently, service rooms are practically eliminated. The heating, ventilating and cooling of such a house is a comparatively simple matter, details of such designs being given further on in this article. The first ones have been equipped with mechanical cooling plants.

Methods of Cooling

Three means of cooling are available and in use today, viz., mechanical refrigeration, manufactured ice, and well water. The choice is governed almost altogether by cost, since exactly the same ultimate results, in so far as temperatures and humidities are concerned, can be obtained with any of these cooling agents. Of the three, ice has been adopted more recently, although it has been used on occasion in older plants. Well water has a field limited to localities where an abundance of water at proper temperature is available from sub-surface wells or similar sources of supply.

A survey of cooling plant operating costs in theaters using manufactured ice as the cooling agent shows that it ranges from 1.1 cents to 2.6 cents per person cooled. This is the actual cost of the ice delivered into the ice storage tank. In a mechanical plant this is compared to the combined cost of electricity for the refrigerating machine motor, water for condensing purposes, refrigerant, lubricating oil for refrigerating machines and salary of operating engineer.

The most generally used method of cooling theaters is by means of a central station plant, i.e., heating, cooling, and conditioning the air at some central point and distributing it by means of ducts throughout the various spaces to be conditioned. Unit conditioners have been applied in some cases, but rarely in houses having over 500 seats.

General Design Data

The load characteristics affecting calculations of equipment sizes are the sensible heat from people, transmission losses through the building surfaces, sun effect on walls and roof, electric lights, and moisture from people and the outside air admitted into the plant. Detailed information, in the form of specific examples embracing each of these items, will be presented next month. Some general data follow:

Outside Temperatures: The designing engineer must have some starting point in his calculations and this would be a determination of the maximum number of people to be accommodated, and looking up authentic records of the highest wet and dry bulb summer temperatures for the locality in which the theater is built. The total heat increment on which air quantities are based is materially affected by the maximum outside dry bulb temperatures and the refrigeration requirements are either increased or decreased, depending upon whether a high or low wet bulb temperature obtains outdoors.

Experience has shown that it is best to select an average maximum outdoor condition as a basis instead of an absolute maximum. For example, if weather bureau records disclose that the highest wet bulb temperature on record for a particular locality is 78°, calculations of capacity are ample if based on 75°. Similarly, if the dry bulb has reached 100° on occasions, the period of duration is not long, and consequently 95° is safe and ample to use in calculations.

As a matter of fact, the capacity of any air conditioning plant installed for comfort cooling is elastic because admission of some outside air into the circulating system is contemplated in the design. Any reduction by the operator of the amount provided for in the design calculations will provide the excess refrigeration capacity required for peak patron loads and maximum outside temperature conditions. At this point it may be mentioned that the dampers regulating the admission of outside air should always be equipped for manual operation.

Inside Temperatures: Common practice a few years ago was to calculate on a basis of maintaining inside temperature of 70° with relative humidity of 50% or 55%, and 75 to 100 tons refrigeration were installed for each 1000 seats. Theater owners themselves were responsible in a measure for these over-sized plants for they spoke in terms of 70° as a proper summer temperature for their houses. Designers continued the use of these figures for some time, until finally, partly due to civil suits inaugurated against the management by patrons who became ill during a performance, the standards were changed. Eventually plants were designed on the basis of maintaining as high as 80° temperature with a relative humidity of 50% to 55% when the temperature outdoors was at a maximum. Even such conditions are considered low when it is 100° or more outside. Under these conditions, with outside air to the extent of 25% of the fan capacity being taken into the system, theater refrigeration requirements are less than 50 tons per 1000 people.

First Cost of Theater Cooling and Air Conditioning Plants‡

	A Few Years Ago	Today
Total cost†	$128,000	$47,500
No. of seats	3200	2800
Cost per seat	$40	$17
Tons of refrigeration per seat‡	94	46.5
Air supply, c.f.m. per person	30	24
Cost of ice cooling plant (2000 seats)	—	$6800[1]
Cost per seat	—	$3.40

‡ The first five items in this tabulation are comparisons between two theaters owned by the same circuit, in the same city, with identical temperatures and humidities maintained.

† Includes cost of heating and ventilating auditorium and lobbies only.

[1] Same temperatures and humidities maintained as in the two theaters compared above. Does not include any provision for heating.

Patron Load: Heat load due to patrons represents approximately 75% of the total heat increment in a cooled theater. The number of seats in a theater plus the allowable or estimated number of standees represents the entire patron load. The number of standees to allow for always presents difficulties. In some cities they are not permitted in the theater proper, in others they may be packed in the space at the rear of the orchestra and balconies, and so on. A rule of thumb for the designer is that the number of standees will be 10% of the number of auditorium seats.

Maximum Load: In theater cooling work, perhaps more than in any other type of comfort cooling, it is a mistake to base the capacity of the cooling plant on a maximum patron load and the most severe conditions of summer weather at the same time. Even air quantities should not be determined with the day of the highest dry bulb temperature outside as the basis. On the hottest or most uncomfortable day, whether it be a high wet bulb temperature or maximum dry bulb temperature, the theater would not be crowded regardless of the character of the show. Box office records show that some people simply will not attend a show on a hot day even if the theater is cool and comfortable.

Air Quantities: Amounts of air circulated varying from 12 c.f.m. per person in some theaters to 35 c.f.m. in others have been used with success and apparently equal results, in so far as temperatures, humidities, uniformity of conditions produced and absence of uncomfortable drafts are concerned. Where existing ventilating ordinances prescribe definite amounts, the engineer has no other alternative but to incorporate them in his designs, or else attempt to have them waived on the plea that the air conditioning plant, even though it supplies less air per person, nevertheless provides more healthful and comfortable conditions for the public than an ordinary ventilating system. Such a waiver has been obtained in several instances.

The aim of the engineer should be to design a plant using the minimum amount of air necessary to produce the desired results. Approximately 15 c.f.m. per occupant is ample for any conditioned theater. With this amount the difference between the air entering and leaving the auditorium is between 18° and 20°. Some of the largest and finest theaters in the country are equipped with plants supplying air at this rate. It is rarely necessary to increase this amount beyond 20 cu. ft. of air per seat. The amount of outside air taken into the plant in maximum weather is usually 5 to 7½ c.f.m. per occupant; the remainder can be returned from the auditorium, in order to economize on refrigeration or heating as the case may be. The return air may be mixed with the outside air *before* the entire body is conditioned and purified[1].

Air Distribution

The designer should exercise care in the plans of the distribution system for a theater. In a theater a person is confined in a seat and, remaining still, is susceptible to changes in temperature or to disturbing currents of air. Minimum air quantities, sound absorption and prevention and proper outlet velocities help to accomplish good distribution.

Upward Flow: The first theaters were cooled by adding refrigerating machines to existing ventilating plants. No changes were made in the air distributing systems, which were of the upward flow type with mushroom ventilators in the orchestra floor, in balcony steps, or grilles in the balcony step risers. This was the conventional method of heating theaters, the air being forced into chambers or tunnels under the floors and admitted to the auditorium through the mushrooms. The cost of changing to downward flow often was more than the entire cost of the refrigeration plant, and owners hesitated at this expense unless forced to by a dissatisfied public. The public, however, was so pleased with the new idea of cooled air that owners

[1] For further information on air quantities, outside air, by-passing and recirculation, refer to the following articles in Heating and Ventilating: "Air Cooling for Restaurants," August, 1931; "Designing a Restaurant Air Cooling System," September, 1931; "Vital questions in Air Conditioning," November, 1931; "Air Conditioning and Recirculation," December, 1931.

were not made aware of any complaints if really there were any; and even today many of the finer houses still retain the upward flow system delivering cooled air under the seats.

If an upward system is used it would be desirable to circulate more air per seat than if the downward type is used, due to the fact that it is more difficult to get a thorough mixing of the introduced air and room air at the floor line. Where air quantities of 25 or 30 c.f.m. per person are prescribed by ordinances, an upward system can be effectively used, for at this rate of supply the temperature rise on the air due to heat added in the theater would be between 9° and 11°. A variety of horizontal diffusion type mushrooms or ventilators have been developed for this purpose. There is a decided saving in some items of installation and first cost with an upward flow system because the supply conduits cost no more than the return system for the downward type. The upward system can be used under the conditions mentioned in any theater whether large or small, open sky or period type.

Downward Flow: In a new theater, and where local ordinances place no minimum limit on air quantities, full advantage of small air quantities can be obtained by using downward flow with supply air openings in the ceiling, side or back walls, the choice depending upon the type or size of the theater. If structural conditions permit the design of an effective and thorough supply system, very little attention need be paid to a return system but one or the other must be arranged to bring air to all portions of the auditorium.

Method of Flow and Type of Theater: The different distributing systems mentioned in the following paragraphs are recommended where small air quantities are used. The large de luxe theater with suspended ornamental plaster ceilings is served well by grilles or openings in such ceilings. The front orchestra and first rows of the balcony can be supplied through open, flush type grilles, while the space at the rear of the balcony and rear of orchestra are much served by air outlets of the drop panel type which provide horizontal distribution. These consist of horizontal plaques built of decorated or ornamental metal, reinforced plaster or light weight composition materials. They are hung from 2 in. to 8 in. below the ceiling line, the distance depending upon the permissible diameter of the plaque or the air outlet velocity selected, or both.

Originally these plaques were designed with openings in the center protected by screens, the idea being to permit some of the air to discharge directly downward to assist circulation immediately beneath the plaque. However, uncomfortably cold drafts were caused and this practice was discontinued. As a matter of fact, it was found that sufficient circulation was provided under plaques of large diameter by the current of air induced by the discharge at the perimeter of the outlet.

In the open sky effect theater ceiling openings were not permitted, for they tended to destroy the effect which this type of architecture sought to create. Air is supplied instead by outlets located in the space between the parapet walls and the outside walls. The air is discharged upward, diffusing on the ceiling which

Unit First Costs—Motion Picture Theaters

	A Few Years Ago	Today
Cost per seat (de luxe theaters)	$500–$700	$200
Cost per cu. ft.	$.75–$1.25	$ .35†
Cost per seat (medium size theaters)	—	$120
Cost per cu. ft.	—	$ .27†

† Includes sound equipment and cooling system.

is arched, forming a long graceful curve. Savings are effected by using this distributing system, as grilles and plaques are entirely eliminated in the main ceiling as well as the necessary distributing ducts required in the theater attic. The return system in houses equipped for downward flow need not be elaborate if the supply system has been carefully designed. A tunnel under each double aisle with aisle hoods or mushrooms will ordinarily suffice.

In smaller houses a rear wall supply system may be effectively and economically used. Only one duct is necessary across the rear wall of the auditorium and concealed behind it, at the ceiling, with outlets directed toward the stage. The openings can be made flush with the wall line, thus eliminating grilles. Outlet velocities depend upon the length of the theater. The return system consists of floor grilles at the rear of the last row of seats or grilled openings in the theater rear wall, thus centralizing and simplifying the entire duct system.

Side wall distribution can be used effectively in houses that are comparatively narrow and long. Great care should be exercised in the arrangement and design of the outlets. Air can be returned by means of grilles in the side walls or, if space underneath the auditorium permits, mushrooms can be used.

Distributing systems supplying air at the front of the theater are also used. Openings with grilles are made either on each side of the stage or in the proscenium arch above, or in both places. The return system can be of the mushroom type through the floor or through grilles at the rear of the auditorium. In systems using a front supply and rear exhaust there may be a tendency toward lower temperatures in the front than in the rear of the theater unless velocities are selected which produce a secondary circulation over the seats as the air travels toward the rear. On the other hand, comparatively high velocities cause undesirable noise in theaters wired for sound pictures. A system designed to supply air at the front of the theater, therefore, sometimes introduces factors requiring unusual attention.

Standees: Standees in foyers and lobbies should be given particular attention in order that they may wait for a seat to be vacated without complaining. Where ordinances permit standees, the designer should provide a sufficient quantity of cool air in such spaces. It has been the practice to care for standees outside the auditorium proper by the excess air flowing out of the theater, but in many cases this has been insufficient, due to this air having already been subjected to the heat

and moisture of the occupants. Further, patrons standing in the foyers and lobbies are continually shifting and moving about and require more cooling effect than the patrons comfortably seated in the auditorium. The air in lobbies and foyers should be augmented with a supply direct from the conditioner, if for no other reason than to offset the odors in the air expelled from the auditorium. In winter this additional supply can be independently heated to a higher temperature than that to the remainder of the theater to compensate for cold blasts entering from outdoors when the door opens.

Location of Apparatus

The air conditioning plant including the heating, ventilating and refrigerating equipment should be located with an eye toward accessibility and convenient operation. Most designers seem to lose sight of this important fact. Generally the boilers are in one location in the basement, the refrigerating machinery in another and the fan, heating stacks and air conditioner are located in back of, or on one side of, the projection booth, 60 or more feet above the basement, over the lobby, in the attic just ahead of the proscenium arch, or over the dressing rooms or stage 70 ft. to 80 ft. above the stage level. Access to these distant spaces is, in practically every instance, by means of long vertical ladders or through long tortuous chambers. In some of the larger theaters where two or three air conditioning units are installed, the one serving the front portions of the orchestra and balcony may be installed in the theater attic over the front of the orchestra or over the dressing rooms, the one for the rear portions of the balcony and orchestra may adjoin the projection booth and the one for the lobbies may be on the roof of these spaces. The refrigerating machinery would be located in the basement. Such designs, and they are not uncommon, call for a staff of operators to service, maintain, and operate the plant. If this equipment were more judiciously designed, it could often be concentrated in the basement with the refrigerating machinery. In that case one operator only could readily handle it all.

There is hardly a theater built where it is not possible to locate at least the refrigerating and air handling equipment in the same room in the basement and in most cases the primary heating equipment may be located in an adjoining room. This results in lower building and equipment costs. Not a few very expensive repair and re-decorating bills have been incurred by owners when leaks developed in heaters and air conditioners located in attic spaces over the auditorium, usually over the front of the orchestra.

Refrigerating Machinery

A survey of cooled theaters will show that many are equipped with but one refrigerating unit. Every theater using mechanical refrigeration should be provided with duplicate units. In some cases, three units are justified, each with 1/3 the total capacity. This opinion is based upon the author's experience in supervising the operation of cooling plants. Daily operating logs of these theaters have demonstrated that where two machines were installed only one was found necessary on an average of 75% of the total number of hours the plant was run in a summer season. This result is due to the fact that houses are seldom fully occupied continuously nor is the weather outdoors always at a maximum, while maximum conditions both outside and in were the basis of design. The additional small cost of installing two small 50-50 units instead of one for the entire load may easily be returned in less than two seasons of operation.

It is not uncommon to see 200 or 300 people in a 3000-seat theater being kept cool with a 200 ton refrigerating plant. Speed regulating equipment for compressors even when of the most expensive type can not compensate for such a load variation. The element of break-down alone is sufficient justification for multiple refrigerating units.

Water Circulating Pumps

Another item often lost sight of by designers is that of proper water circulating pumps. Two pumps should be provided with every cooling plant—one for circulating the cold water when cooling is required, and one to supply water to flooding nozzles over the eliminator plates of the conditioner for cleansing the air when the cooling plant is not in operation. This latter pump in the largest theater would require only about a 3 hp. motor. Better operating economy can be obtained by operating such a pump for the two thirds of the entire year when it must operate than by using the large pump which may be from five to twenty times larger, depending upon the size of the theater and the location of the air conditioning equipment with reference to the refrigerating machinery.

Condenser Water Cooling

Condenser water cooling equipment consisting of cooling towers of the atmospheric, forced or induced draft type, or spray ponds, are used in some installations where city water costs are high or where city water temperatures are such that prohibitive amounts would be used. However, these cases are rare. In some instances they are installed because of a possible shortage of city water. Spray ponds have been found effective and satisfactory. They can be installed readily on theater roofs at reasonably low costs.

Noise Prevention

With the advent of sound pictures in theatres, a serious problem is presented in eliminating noises produced by the air cooling equipment and in the air duct system. It can be met successfully by employing acoustical materials, by following basic acoustical principles in arranging the equipment, and by providing proper sound- and vibration-proof foundations for moving machinery.

A Designer's Thoughts on Theater Air Conditioning Operation†

A designing engineer feels that theater owners should be better acquainted with their plants and that the design must take operation into account.

Fig. 1. Interior of modern theater.

DURING the past five years most theater managers have awakened owners to the desirability of air conditioning until it is now regarded as a competitive necessity. The question no longer is whether to have *refrigerated* air as in the early plants, but rather how small can the investment be and still make patrons conscious that cooling is being provided.

When the equipment is once installed and accepted, it is all too often considered in the same way as are motor generators and other power equipment, in the sense that all one has to do is to start the equipment and the air soon becomes cool—much as opening a radiator valve heats a room. This is as it should be, but it is contended here that the owner has an appalling lack of knowledge of the difficulties involved. It is not merely a question of starting up the equipment and then letting it run. Ask the man who operates one. Where inadequate plants are installed it is more often the fault of the owner than of the conditioning specialist.

It is time the owner realized his responsibility. To dictate the condition of the most personal thing we know—physical well-being—is a serious undertaking, and his self-assumed role takes on profound importance. It is a delicate responsibility.

We have learned engineers, writing and talking the most hypothetical phases of this comfort business, while, on the other hand, are operating engineers who are at wit's end to prevent complaints in order to retain their jobs.

The operator and owner are not the only ones concerned. Consider also the designer and the contractor.

The results obtained by the designer are often seriously hampered by the necessity of meeting architectural requirements. Again, severe competitive bidding usually ends up with the trimmings thrown out. Add to these difficulties, inadequate appropriations and it may well be that contractors are asked to make amazing attempts to fulfill their guarantee.

In the guarantee lies the chief, but subtle, dividing line which separates air conditioning from heating and ventilating practices—and it has caused contractors a lot of grief. As a specialist in air control, the contractor guarantees in substance, to provide and install a system which will maintain a stipulated temperature and relative humidity under certain limitations, with a maximum deviation of plus or minus x° and y%. This is no small undertaking when the many variable conditions are considered.

Assume a large cubicle, the rudiments of an assembly room. There are no stage, no doors, no windows, no cracks. The seats are uniformly spaced and each is occupied by a man chosen for excellent health, hardiness and ruggedness. All are normally but identically attired. The lighting is constant and there is 6 in. of cork on the floor, roof and all four sides. Here would be a designers' and contractors' paradise, but unfortunately theaters aren't built that way. Since this fact must be faced let us note a few of the ways that the theater as built affects this ideal condition.

Imagine first that the cork is removed. The equipment must play a dual part, since during the summer time air entering at the ceiling is less dense than during heating in winter. The guarantee is to be met with fixed locations of supply and return grilles under reciprocal conditions of density differences between the room air and the delivered air, for this governs distribution entirely, all other things being equal.

Suppose, further, that the lights all go out at once. Add a stage with an open skylight at the top. Now add a 15°, 40-mile gale right at the lobby doors, then take it away. Add a ten-story building across the street

† Contributed.

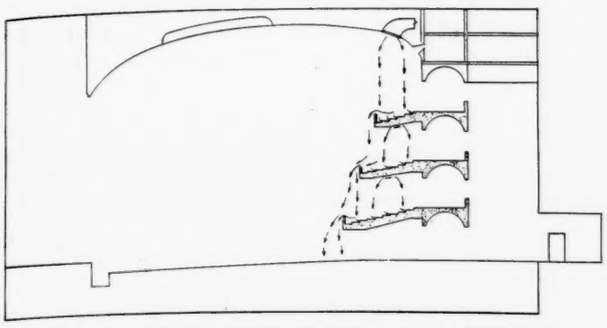


Fig. 2. "Spilling" of cooled air causes chilling of those under the mezzanine rail.

casting a shadow moving slowly across the entire south side of the theater building. Add 259 standees for fifteen minutes and then suddenly take them away and let the July sun come out from behind that cloud. Instantly add 5000 B.t.u. per min. of stage lighting. Now add two mezzanines with thirty people in the top one and 401 in the first, and leave only 66 people under the first mezzanine. Exchange half the men for an assortment of women, children and bald-headed old men. Add a lobby. Add 32 exit doors, and constantly oscillate any three doors connecting to the lobby. Add a movie which excites six-tenths of the people, thrills three-tenths, with one-tenth in a doze. Add an organ blower (infiltration), open the stage skylights which cause a stack effect (exfiltration). Open a stage door for a minute with air rushing in. Add 12 exhaust fans. Finally add an undiscovered crack in the plenum chamber.

We might also take out all the people and bring in a new bunch, fill every seat, pack the place, in fifteen minutes. The news reel will start in just a minute.

These are the conditions actually taking place instead of ideal ones. Is it difficult to see why control and attention are necessary in operation, and why the most careful design is worthless without them?

The disturbing factors are not loads such as radiation gains or losses, or sunshine or general illumination. The most difficult ones are the local influences, such as the position of a door, or the general degree of tightness of the construction. What is needed to overcome them are experience and an intimate knowledge of air conditioning and its application to the theater.

The smaller and narrower the limits set for the permissible variation in the guarantee, the greater is the need for special experience and careful design in air conditioning practice. On the other hand, wide limits do not result in maintaining the expected conditions.

Thus far the following difficulties confronting the automatic production of sensibly constant comfort for all patrons in the theater have been mentioned briefly.

1. The failure of owners and managers to appreciate the importance of their attempt to create comfort; and their failure to understand the difficulties involved.
2. The gap between temperature, humidity and air motion theories in some engineering circles, and the operating group which is expected to operate with a lack of adequate equipment and knowledge.
3. The paring down to meet competitive bidding.
4. Inadequate appropriation.
5. Difficulties encountered by designers and contractors in fulfilling a narrow-limit guarantee.
6. Architectural impediments, particularly to proper year-round distribution.

To the above might be added the following which are self-explanatory.

7. Improper design, and rule-of-thumb engineering, including designing by men otherwise experienced in heating and ventilation.
8. Economical restrictions on effective operation largely reflected through insufficient meters and gauges for intelligent generation.
9. Untrained operators.

After the many variables in heat engineering are superimposed on the factors just listed is it any wonder when installations fail to meet minimum requirements?

Theaters contain everything from a crude assembly of sheet metal and pipes to equipments which, for an additional 2% of the initial cost, could be made into high grade installations. The 2% applies to facilities for really intelligent operation, and means of recording operation not as a matter of adding glittering gadgets, but gauges and meters for cost-keeping and the detection of unsatisfactory conditions.

The point is that the owner feels that air conditioning is expensive to install and operate, and that meters and gauges are merely embellishments which serve to lighten the duties of the operator. These accessories for the refrigeration are invariably provided as standard equipment, but the vital elements of the air handling apparatus seldom receive the necessary consideration. During a show the operating engineer should not walk down the orchestra aisle whirling a sling psychrometer. Or should he?

The purpose of this article is to urge that owners and managers be intimately enough acquainted with the nature of air conditioning apparatus to ensure their receiving adequate equipment, and to call the attention of designers to the fact that they *must* give constant consideration to the functioning of the apparatus under operating conditions and the facilities for satisfactory performance.

In the ensuing paragraphs the author ventures some suggestions to designers, who should bear in mind that the factors governing design are so varied that it is highly probable that there are many instances in which these conditions do not apply.

Not so long ago the author had the opportunity to survey 32 theaters. This survey revealed some very interesting points, not only to designers but to all concerned.

The general lack of knowledge of psychrometry on the part of operating engineers was surprising. Many know there was a chart, an ice machine and one or two wet bulbs lurking around the system somewhere. Fortunately, though, there are some operators who, largely of their own volition, have learned enough about psychrometry and the idiosyncrasies of the system they operate to reduce complaints to a minimum, but not without exercising considerable ingenuity at times.

It seems that the necessary information is seldom volunteered to an operator. One would think that in bidding for reputations of superiority, contractors, as

the ones last concerned with a plant before it is turned over to an operator, would be particularly anxious to train the men who operate the systems. If not the duty of the contractor, certainly some one should be made to furnish them with a good working knowledge.

Believe it or not, several theaters had compressed air control diagrams which did not portray the control as installed on the jobs. Some operators abandoned parts of the automatic control. Others were aghast at the idea of changing the setting of a thermostat. In nearly every instance the engineer had no conception of the control piping.

Frequently, operating engineers had not been furnished with plans of the ductwork as installed.

On one installation a relief air opening to the outside is useless whenever a breeze blows directly against this side of the building. On another there is so much leakage outward that the relief provided is never used.

One point brought to light by the survey is that most of the operators encounter trouble in winter when the wind blows on the doors leading to the entrance foyer. At such times cold gales often ride right through the foyer and into the house, severely chilling those in the rear. Many of these theaters have high foyer ceilings where the air supply outlets are located. While the blast heaters for use in winter were no doubt of sufficient theoretical capacity, they do not heat the air passing through quickly from the outside. In contrast to the experience of the people at the rear of the orchestra, those on the first tier, which opens into the foyer, are perspiring (See Fig. 3).

A common practice found during the survey, and one which should be corrected, is that of relieving house air through the foyer and lobbies to the sidewalk in summer. This frequently creates a malodorous condition even at the ticket booth.

In several theaters the ductwork had been altered to meet a standee condition not originally provided for, with the consequent sacrifice of fan capacity elsewhere which, according to operators, created an inherent difficulty in the main space supplied.

In instances where managers called in a supervising engineer due to an insufficiently cool house, it was surprising how frequently the compressor was found to be undercharged.

Dirty condenser tubes seldom were found and it may be concluded that they do not usually cause a noticeable drop-off in refrigeration capacity in New York. However, on one job at the end of a season, the author witnessed the cleaning of tubes in which the coating of scum accounted for the fact that with every other thinkable effort made to increase the output, only 85% of the refrigeration rating could be attained.

Frequently, operators complained that the musicians' pit is too warm in summer and too cold in winter. Getting air to this pit under effective control, while preventing the rippling of the street drop or scrim, is a delicate proposition.

While other operating difficulties were encountered, the instances cited are numerous enough to bring to the reader's attention the fact that a good design cannot be made unless operation is fully considered, and constantly borne in mind.

One way to reduce complaints is to provide remote temperature indication from at least six orchestra points and two on each balcony. Elements are now obtainable for attachment to the backs of seats which are rugged and tamper proof. To provide only a dry bulb recorder or indicator in the return air dust is inadequate. A wet bulb indicator or recorder also should be provided and every means should be taken to see that both are kept in good condition. Dirty wet bulb wicks may be worse than no wet bulb reading at all, as an error of 1° means an error of about 4% in relative humidity.

The operating engineer should determine by test his minimum and maximum fresh air, return air and recirculated air quantities. A Pitot tube test of the air quantity handled by the fan is necessary to intelligent operation. He should also know precisely how much water is being pumped through the coolers, as well as the amount handled by the recirculated spray water pumps where these are used. Each compressor unit should have its own kilowatt hour meter and condenser water meter. A two-point recorder should be provided to show the temperatures in the supply and return cold water headers together with a flow meter for determination of the actual refrigeration load. There should be thermometers in the recirculated, discharge and cold water supply pipes at each dehumidifier pump. An outdoor dry and wet bulb temperature recorder is considered indispensable for economical operation as well as good results.

Realizing that the temperature of the air leaving a dehumidifier is not constant over the entire height, some prefer to locate the dew point thermostat in the pump suction. In any case knowing the true average dew point of the air leaving the dehumidifier is essential. Air from the recirculation connection, when used, must not interfere with the dew point thermostat.

When providing some method of ozonizing or otherwise activating the air, it is a mistake to diminish the fresh air quantity from that considered good practice without the use of this apparatus. Filters should always be installed to preserve the fresh appearance of the interior.

The addition of the equipment listed and furnishing information for the operator may be considered as refinements. However, such items may well be likened to the water temperature gauge on an automobile, which used to be an extra, but the buyer now appreciates its importance, because for small cost, it is an index to costly trouble from sources which do not receive regular inspection.

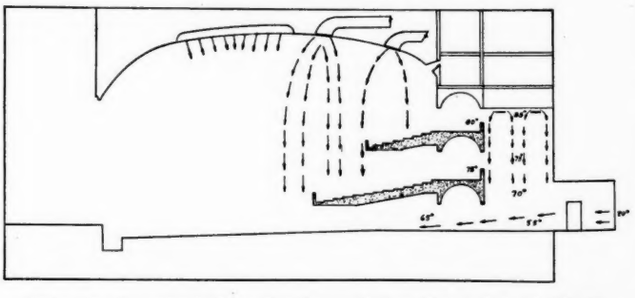


Fig. 3. A case where in the winter the cold air from the lobby chills the patrons in the rear orchestra.

One of the hardest things to contend with is designing successful means of distribution in accordance with the architectural treatment. Entirely too frequently designers overlook the fact that the relative location of the returns is an all important consideration in the fixing of air motion. Best air motion is obtained when the air is definitely moved toward the faces of the audience. Wider variations in conditions can be withstood with gentle yet positive air motion in this direction. However, the air must not travel along too great a horizontal distance in the occupied zone; otherwise, an appreciable pick-up in temperature will result. Returning all the air delivered to the orchestra space to the rear rail is not to be recommended for this reason. Furthermore, when this air stream cuts through the supply from the soffit of the first balcony, conditions in the rear of the orchestra space have but slight chance of being satisfactory.[1]

Designing for the maintenance of 70° to 75° dry bulb and 60% relative humidity inside, against 95° air outside is a decidedly objectionable practice. It is the aftermath of the days when cooling was an innovation. Competitive bidding and low budgets can also be held responsible to some extent. Effective temperatures have but limited meaning in helping us to establish the criterion of comfort indoors for theater patrons, largely because of the shock experienced by many from large temperature differentials between indoor and outdoor conditions and because of the varying reaction of different individuals to the same condition.

Theater managers themselves are largely responsible for over-cooling, because they do not fully appreciate the importance of relative humidity. Maintenance of a higher relative humidity at the same temperature makes a cheaper installation for bidders and costs less to operate, but a lower relative humidity of, say 50%, with a dry bulb temperature of 79° or 80°, produces not only a more delightful atmosphere but is less of a shock to patrons on entering and leaving the theater when the outside temperature is 92° or over.

Theater owners must bid for comfort and wholesomeness of air rather than for large temperature differences between inside and outside. Spectacular showmanship in the form of over-cooling actually keeps many people away from the movie houses. After learning that the wet bulb temperature of the theater air is always lower than the dry bulb temperature—which is the only one the ordinary patron knows about—one manager arranged for a wet bulb recorder to be placed near the entrance.

Frequently, when managers order the engineer to maintain a lower temperature in the house, it is done at the expense of a higher dew point, thereby raising the relative humidity, or by reducing the fresh air quantity, resulting in stuffiness, a prevalent symptom of poor design or operation, or both.

The author urges the design for and maintenance of lower relative humidities and smaller temperature spreads between indoor and outdoor conditions, particularly when street temperatures are soaring.

Over-cooling the balconies seems to be an inherent difficulty. In many houses air from the main ceiling equipment falls on the lower mezzanine when it projects considerably beyond the upper one. This presents a difficult problem (See Fig. 3). A rather fundamental move was made when the benefits accruing from separate equipment serving the mezzanines were first contemplated. This was only the beginning in the right direction. This division of equipment is as economic as it is necessary for control, in that a higher entering temperature is permissible at the outlets in the main ceiling, thus reducing the amount of recirculation

[1] *Editor's Note:* The author refers to his own experiences. There are various methods of distributing air and the remarks do not necessarily apply to all theater work.

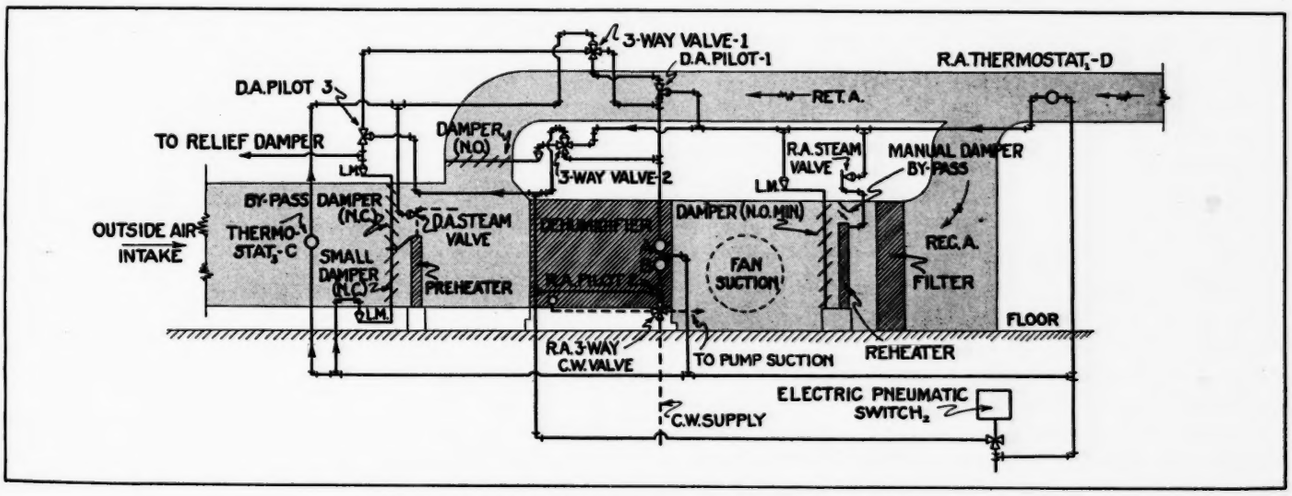


Fig. 4. A control diagram for a recirculating plant.

SYMBOLS AND ABBREVIATIONS

RET. A.—Return Air.
REC. A.—Recirculated Air.
D.A.—Direct Acting.
R.A.—Reverse Acting.
C.W.—Cold Water.
N.C.—Normally Closed.
N.O.—Normally Open.
L.M.—Lever Motor.
A.—D.A. Winter Dewpoint Thermostat, 40°-48°.
B.—D.A. Summer Dewpoint Thermostat, 50°-56°.
C.—Outdoor Thermostat.
D.—Return Air Thermostat.

[1] With wide range; slow, gradual acting, with adjustable restrictor.
[2] Wired across all compressor motors; located in refrigerating room.
[3] Quick acting.

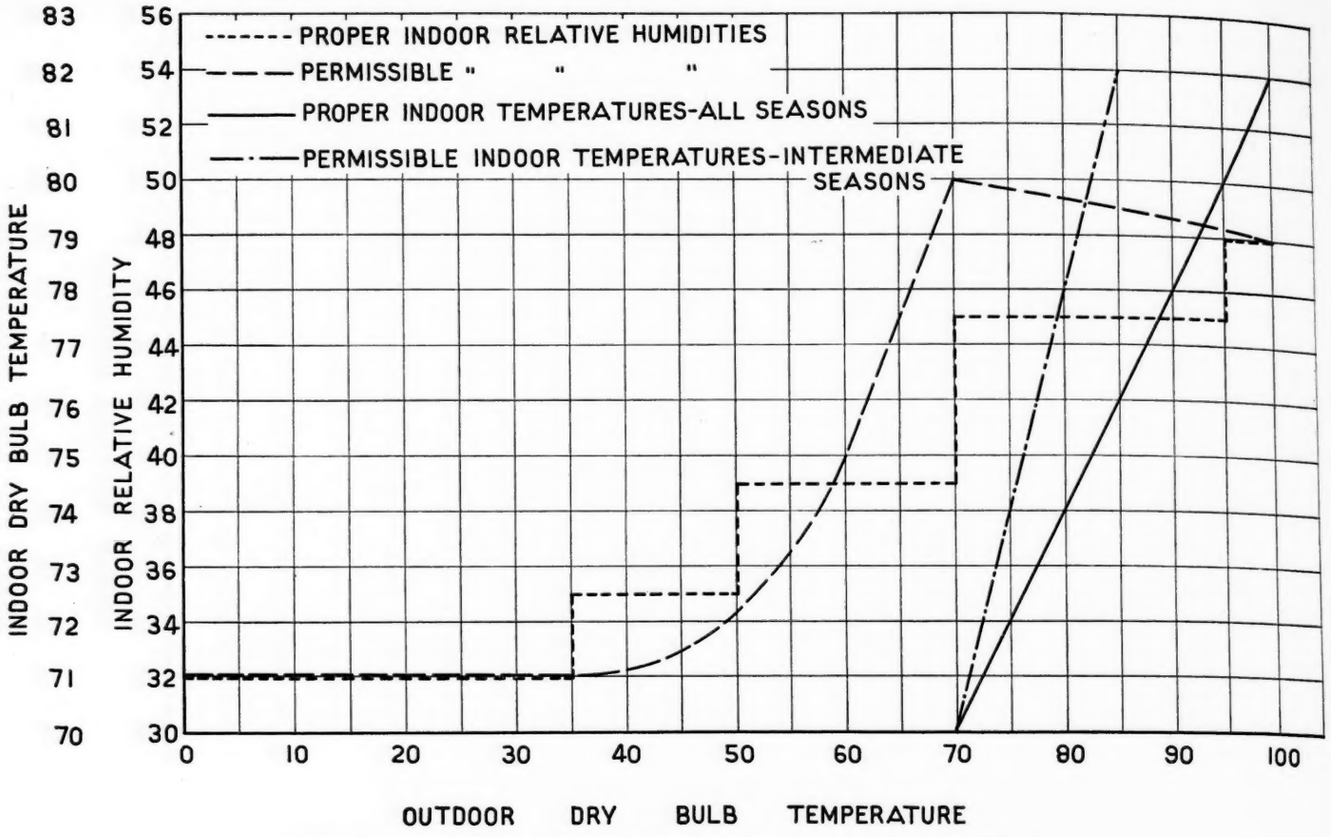

PROPER INDOOR RELATIVE HUMIDITIES
PERMISSIBLE " " "
PROPER INDOOR TEMPERATURES-ALL SEASONS
PERMISSIBLE INDOOR TEMPERATURES-INTERMEDIATE SEASONS
INDOOR DRY BULB TEMPERATURE
INDOOR RELATIVE HUMIDITY
OUTDOOR DRY BULB TEMPERATURE
83 82 81 80 79 78 77 76 75 74 73 72 71 70
56 54 52 50 48 46 44 42 40 38 36 34 32 30
0 10 20 30 40 50 60 70 80 90 100

Fig. 5. A suggested relation between indoor and outdoor conditions.

and consequently the fan capacity for the main ceiling dehumidifying equipment.

In theaters where the distance between the seats and soffit is small over-cooling is a menace unless precautions are taken for individual control for each mezzanine and for the rear orchestra under the first mezzanine. In the case where there is but one large mezzanine this is just as advisable. It can be seen that when one distribution system supplies the rear orchestra and all mezzanines without individual control in these spaces an inherent difficulty obtains, as the theater fills up or as the sections are partially occupied. Uniform distribution of patrons is the decided exception, occurring only when all seats are filled, or nearly so. When controlling from the average return air temperature from all these spaces, if the mezzanines are only partially filled during this period, they are over-cooled, while the rear orchestra space is warmer than desired. All the operating engineer can do under these circumstances is to set the return air thermostat for a happy medium between his observed rear orchestra and top balcony temperatures, and to keep making adjustments in accordance with the changing population distribution.

No doubt the customary practice of relieving orchestra air through the rear of the house is largely responsible for the trouble so often experienced in getting the rear orchestra temperature down.

When using return air as the control medium, a surging effect is apt to occur due to the lag in time between change in damper setting and temperature readjustment at the thermostat. The amount of the lag depends on the rate of air change and, sometimes, the length of the ductwork. The lag results in alternate over-heating and over-cooling and is one of the serious problems to be overcome in designing a workable control.

Many operators speak of "balancing the house," meaning that with a suitable fresh air quantity which is not excessive for refrigeration and yet which offsets odor, sufficient pressure is maintained to provide relief into the lobby while counteracting excessive infiltration. On a proposed theater no one can predict just what the amount of natural leakage from the house will be, yet excessive pressures cause trouble by bulging the curtain.

Fixed Area for Air Exhaust Often Too Small

The question of odors is vexing and worth discussing, as it is related to the preceding paragraph. Inspection of theaters cannot reveal what quantity of outside air the designer had in mind when refrigeration is running and patronage at a maximum, but it can be said with certainty that even if good judgment is used in designing for an adequate amount of outside air, many theaters do not actually receive this amount. This is not because the fresh air damper openings are not large enough. It is usually because the theaters do not have enough fixed area for egress of air when the show is on. In a well-designed house the entrance foyer should have conditioning under separate control and the designer should take definite steps to be sure that the fresh air quantity allotted will actually be realized, either through the provision of an exhaust fan or of relief air ducts with automatic dampers.

When doors to the foyer are normally in closed positions, steps to procure relief are necessary. This is a

consideration which is too frequently overlooked, particularly by designers who figure on using the outdoor wet bulb to produce all of the cooling power it is good for. Under this condition when the quantity required through the fresh air intake equals the capacity of the dehumidifier, its full cooling power will not accrue unless provision is made for the relief of this air quantity.

No matter what quantity per person is assigned to a proposed design on paper, this in itself is not the final answer to the odor problem. Proper provision for air egress is absolutely essential and mezzanine excess is bound to "spill" and cause trouble unless preventive measures are taken. The air from the top balcony rolls down and spills over the rail onto the balcony below and so on until at the orchestra those who sit near the first mezzanine rail line "get it." Fig. 2 illustrates this condition.

It is well to combine the lighting fixtures with the supply outlets on the mezzanines whenever possible in order that the heat can be immediately absorbed, for the closer the entering air temperature approaches the temperature it is desired to maintain, the better, consistent with air velocity and direction.

In arriving at the installed tonnage this usually need not be the sum of individual maximum calculated loads because lighting, population and outdoor loads are rarely simultaneously at a peak. When making an allowance for a safe deduction from this maximum figure, the time element of the peak lighting load may be the most important consideration. Again, unless the interior loads are to be at a peak for a long period during the afternoon, a lower outdoor wet bulb than the afternoon maximum may be used.

Fig. 4 shows a control for a main ceiling theater equipment. The winter dew point thermostat (A) utilizes fresh and return air to maintain a water temperature corresponding to its setting. If the outdoor temperature is below 35°, the winter dew point thermostat must have control over the pre-heater bypass damper through control of outdoor thermostat (C), otherwise at 34° outside overhumidifying will result.

Whenever it is above 35° outside, but under conditions not demanding refrigeration, the return air thermostat (D) dictates whether the dew point thermostat (A) exercises any control over the preheater bypass damper.

The return air thermostat fixes the house temperature in all seasons, but only controls reheating through the air heater and the c.f.m. recirculated in winter.

At the instant refrigeration is cut in, the entire control is changed.

Air entering the dehumidifier casing is no longer determining water temperature, but water temperature is fixed by the summer thermostat (B) which determines the leaving dew point.

The fresh air preheater by-pass cannot open under these conditions, for reasons of refrigeration economy, and the return air damper is taken out of control of the dew point thermostat (A) and is under control of the return air thermostat (D).

If the water temperature rides up beyond the setting of the summer thermostat, the reverse acting pilot No. 2 prevents the recirculation pump from pulling air from the then empty cold water line. This assumes the use of a separate cold water pump for the coolers. Pilot No. 1 permits the preheater by-pass damper to utilize the outdoor wet bulb for cooling in accordance with demands of the return air thermostat.

This type of control fixes the relative humidity by controlling dry bulb and dew point temperatures and the only manual attention required throughout the year is to change the setting of the dew point thermostat to compensate for moisture pick-up, and the return air thermostat to vary the temperature in the house in accordance with the outdoor temperature. Fig. 5 shows a suggested relation between indoor and outdoor conditions.

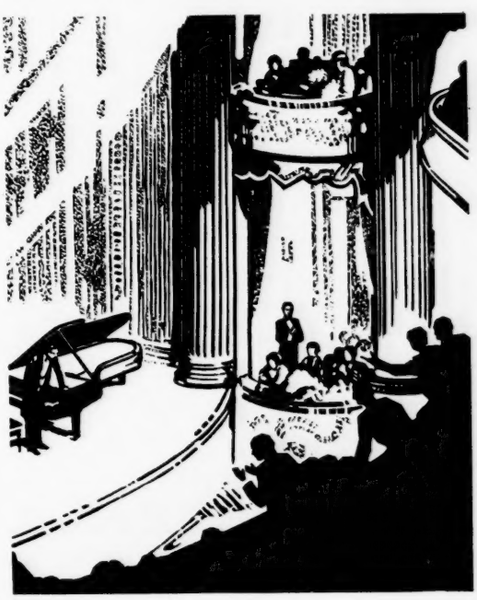
This method of control requires that the operator know what is going on in the house. It is believed that while a control should be fool-proof, it should not be fully automatic, as it is well to force the operator to pay attention to conditions in the house at frequent intervals.

Careful Design, Intelligent Operation and Adequate Facilities Necessary

Intensive competition in showmanship has given the modern theater a trend toward lavish display in interiors, huge appropriations for interiors, but the only improvements in mechanical equipment, a vital necessity, have been made by manufacturers.

It should be impressed on owners that the interior decorations or a particular show may not be wholly to one's taste, but he knows the right film will "pull." But should a theater obtain a reputation for chilling or draughts on the neck, his patronage falls off.

The theater owner assumes a serious responsibility when the personal comfort of patrons is dictated. The public knows air conditioning largely through the theater and it is up to designers as well as owners to give the matter of comfort the best money can buy.



Too much emphasis, therefore, cannot be placed on a careful, adequate design, coupled with a desire on the part of the owner to maintain refreshing, wholesome, comfortable atmospheric conditions. This is predicated on comprehensive design followed by intelligent operation, together with adequate facilities. This is true, particularly if the rapid strides currently predicated for air conditioning are to be realized.

Notes on Air Cooling with Ice

While relatively few theaters are now cooled with ice, many of the smaller houses unable to afford mechanical refrigeration may use ice as the cooling medium. General principles of ice cooling are outlined in the accompanying article.

ICE has been used to cool theaters and other spaces by blowing a current of air directly over blocks of ice. This method results in a lowering of the dry bulb temperature but does not dehumidify to any extent as the great bulk of the air does not have its temperature lowered to the dew point. Such attempts have not been successful or satisfactory and, largely as a result, ice as a cooling medium was brought into disrepute.

Proper methods of using ice for air cooling can be understood by recalling that dehumidification by cooling can be accomplished by passing a current of air through a spray of water whose temperature is lower than the temperature of the dew point. In methods using a spray and mechanical refrigeration the spray water is cooled by passing it through heat transfer apparatus which may be located either inside the conditioner or outside it. The principal point is that there be available at the sprays an adequate supply of water at the proper temperature and with the temperature under control. Exactly the same point should be observed in applying ice for the cooling medium. If ice is to be successfully used, the apparatus should be so arranged that a supply of water at the proper temperature is delivered to the sprays. Enough ice must be melted in cooling this water to maintain this temperature against the attempt of the passing stream of air to raise it.

Ice for cooling the water may be introduced either directly into the washer, and there melted, or it may be melted outside the washer.

If placed inside the washer it may either be immersed in the water in the bottom of the casing, or it may be suspended above the water.

If placed in the water, the melting rate and the heat extracted from the water, will depend on such factors as the amount of ice surface and the temperature of the water. As the temperature of water approaches the temperature of the ice the melting rate will become slower and slower with a given amount of ice and water. Control of the melting rate and water temperature is difficult to obtain.

If suspended above the water in an open washer the ice is in the path of the air stream and is played upon by the spray water. Again control of the melting rate and water temperature is a problem.

If placed outside the washer the ice must be protected against wasteful melting. This is accomplished by using an insulated ice bunker. The water from the bottom of the washer must be sent to the ice chamber, cooled, and returned to the sprays at a suitable, controlled temperature. Ordinarily this temperature is about 5° to 7° below the dew point temperature. If 80° dry bulb and 70° wet bulb are being maintained the dew point temperature is 66°. From this it will be

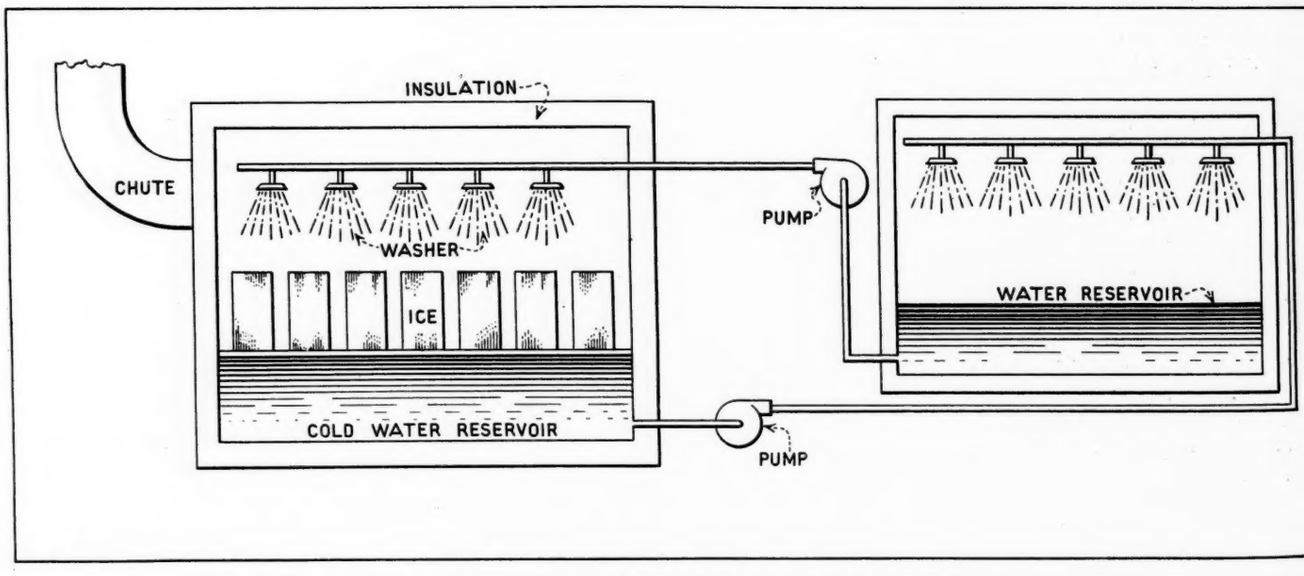


Fig. 1. Two pumps are required with this method, in which the cooled water is sprayed over the air to be cooled.

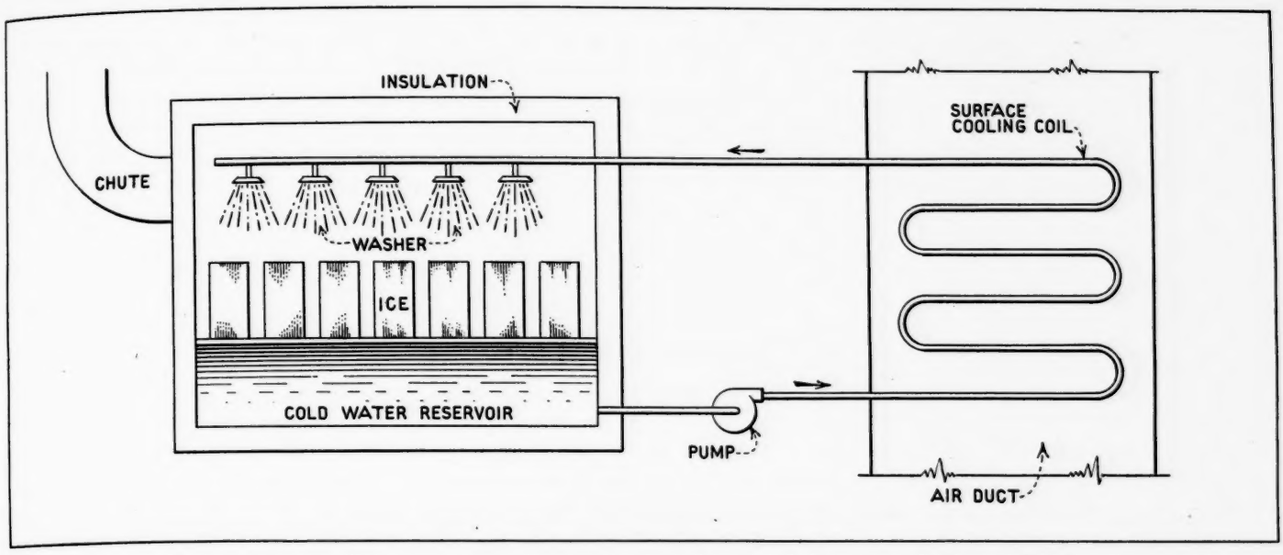


Fig. 2. With this arrangement only one pump is needed, the water being confined to a closed circuit.

seen that the temperature of the water at the sprays need not be reduced to the temperature of melting ice but is considerably higher.

Several Methods of Arranging Apparatus

Several general methods of arranging the apparatus are available. One is shown in Fig. 1. This method causes the warmed water from the washer to be pumped to the ice bunker and sprayed over the ice. Another pump returns it to the washer sprays. Fig. 2 shows diagrammatically how one pump may be used instead of two by using a cooling coil instead of a washer.

Use of an insulated ice bunker instead of putting the ice directly into the washer has several advantages. First of all, since the bunker may be put in any convenient place, it may be so located as to be readily served with ice with a minimum of labor. Second, it makes possible arrangements for controlling the melting rate and the temperature of the water going to the washer sprays or to the surface cooler.

Control is essential, and must be so arranged that the water temperature can be kept steady regardless of changes in the amount of ice in the bunker and of uneven melting of the blocks.

Among the factors governing the melting rate is that of the amount and temperature of the water sprayed over the ice. The temperature of the water entering the ice sprays depends on that in the bottom of the washer casing. It would obviously be possible to keep the temperature of the water entering the ice sprays constant by mixing the warm water from the bottom of the washer with the cold water in the bottom of the ice bunker. The amount of water passing through the ice sprays could be varied by by-passing part of the water from the bottom of the washer to the bottom of the ice bunker without passing it through the sprays.

Another item in control is whether or not the ice is immersed in the water in the bunker. If immersed, the temperature of the water will approach the temperature of melting ice as long as there is a supply of ice to melt. If suspended above the water the ice will melt but slightly if no water is sprayed over it. Several methods of securing control are thus possible but the details of those now in use are not available. It is apparent, however, that control is essential to successful application.

Calculations for Ice Cooling Similar to Those for Mechanical Refrigeration

In dealing with ice as the cooling medium, it bears the same relation to the plant as does the refrigerating plant in a house cooled by mechanical refrigeration. The ice merely acts as the agent for keeping the spray water properly cool. Any arrangements of by-passing, recirculating or reheating may be accomplished in exactly the same way as is done when mechanical refrigeration is used. The same applies to distribution methods.

Computations of the cooling effect required are exactly similar in the two cases. The computation in fact is commonly made in terms of tons of effect even when mechanical machines are used. The melting of one ton of ice is commonly taken as 288,000 B.t.u. The heat is extracted rapidly or slowly, depending on whether the melting takes place rapidly or slowly. If done uniformly in 24 hours this is at the rate of 200 B.t.u. per min. If done uniformly in one hour the rate is 4800 B.t.u. per min.

When the maximum melting rate is known the amount of ice to be provided for in the bunker can be estimated by fixing the servicing interval on the peak day.

The Ejector System as Applied to Theaters

By ANDRE MERLE†

IT was the capital and courage of theater owners which has made comfort conditioning what it is today. They it was who supplied the buildings in which much experimental work was done. Now such installations represent a high degree of perfection in ventilation practice.

Theater owners, in keeping with existing conditions, are now demanding installations at low prices. The ejector method has advantages in that it permits considerable savings to be made, especially in sheet metal duct work. The principle of this method of distributing the conditioned air is to use relatively small air quantities at relatively great differences in temperature from that to be maintained. The air is delivered at high outlet velocity, and the jet causes a secondary circulation to be set up which moves the air already in the conditioned space and mixes it with the air being supplied. This permits the use of small air quantities and results in apparatus of small size at correspondingly lowered cost.

This method is not adaptable at present to all houses. Good judgment must be exercised in attempting to use it. This is apparent from a study of Fig. 1. Air from the conditioning apparatus is led to ejector nozzles and discharged to the room. It sweeps along the ceiling propelled by the velocity of the jet. As it mixes with the air in the space it gradually descends to the occupied space and is withdrawn through return grilles, sweeping across the audience from the front. Successful application has required first of all that there be a flat ceiling with no drops, beams, lights or columns directly in the path of the jet. The size of the auditorium is also a limiting factor, as blows of over 200 ft. should not be attempted. A minimum ceiling height of 12 ft. also seems necessary. Attempts to apply the method to space in which the height is out of all proportion to length are also questionable at present.

In general, the nozzles are located in the rear of the space and the return air is also withdrawn at the rear, as illustrated in the figure. Care must be exercised to prevent both drafts and noise. Present practice calls for the installation of sound absorbing apparatus both between the fan and the ejector header and in return air ducts.

The question of the amount of air to be handled with this method is interesting. The writer believes that the rule of thumb, which calls for 30 cu. ft. of air per person per minute, is obsolete. There can be no such fixed rule. Neither must the quantity be guessed at on an air change basis. Eventually, engineering principles must be applied to the solution. In this method of distribution as in any other, final results are what count. As in any other method, also, the quantity depends on the difference between the temperature of introduction and the maintained temperature. This should be made as great as possible while maintaining adequately uniform and comfortable conditions in the occupied zones. At present it is not possible to predict what the actual least amount possible may be. However, enough successful installations using

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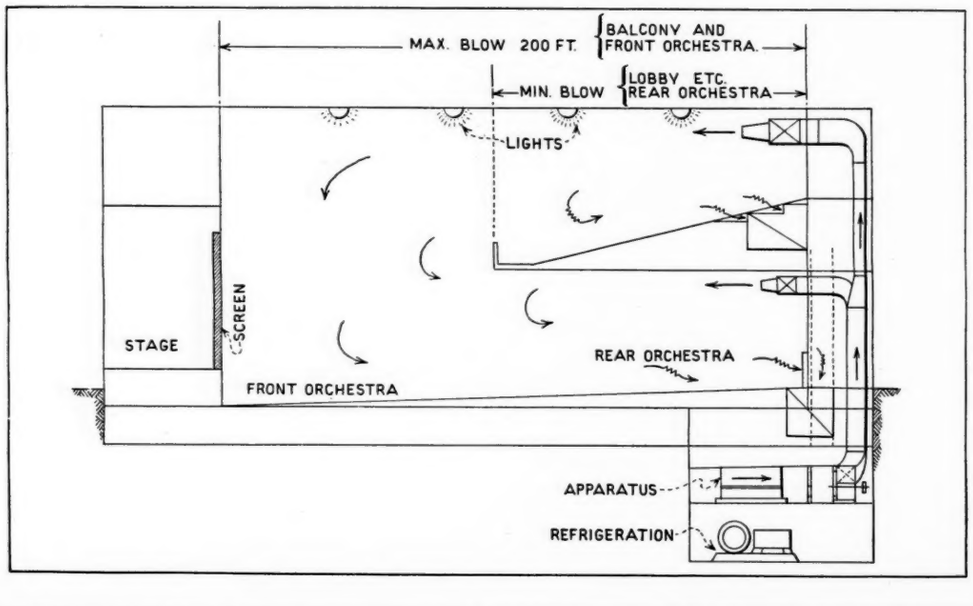


Fig. 1. General arrangement of ejector system showing air travel.

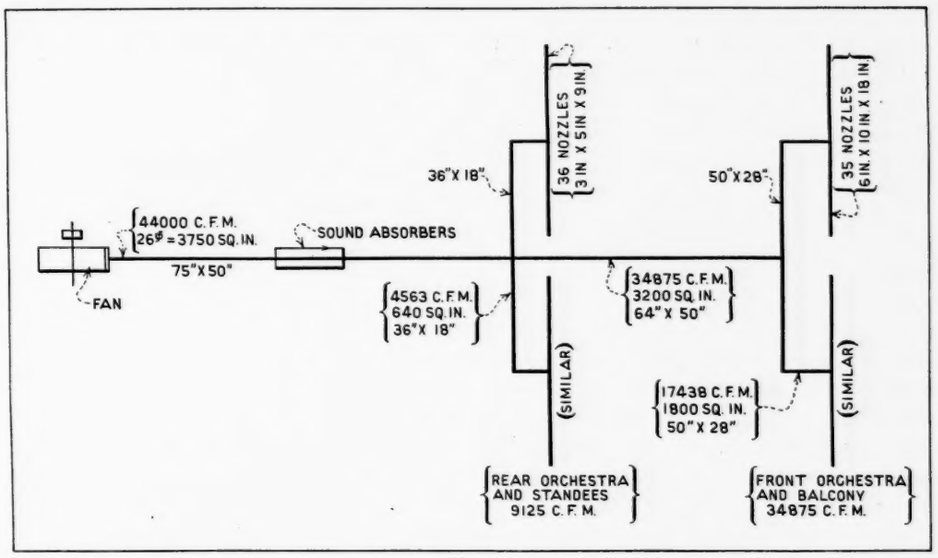


Fig. 2. Schematic arrangement of supply ducts and nozzles for example given by author.

from 15 c.f.m. to 20 c.f.m. per person have been made to conclude that the system will operate with these quantities. Due to the secondary circulation set up by the jets the use of these small quantities seems to produce results comparable with those produced by handling double the amount with some other methods.

When the quantity of air to be handled is thus fixed, the difference in temperature between this air and that to be maintained must be adjusted to a point which will permit the treated air to pick up or give off the amount of heat and moisture required by the load. In applying the method to a given installation, either the heat load may be calculated and the entering air temperature selected, or the amount of air to be handled may be selected and the entering air temperature adjusted as necessary. In the example which follows the air quantities will be fixed in accordance with present practice, allowing approximately 20 c.f.m. per person.

As an example, take a medium-sized house seating 2100 and allowing for 100 standees additional. The house is to be maintained at 77° d.b. and 60% r.h. against an outside temperature of 95° d.b. and 75° w.b.

On the basis of 20 c.f.m. per person to be handled the total air quantity is 2200 x 20 = 44,000 c.f.m. This may be proportioned in accordance with the subdivisions of the seating arrangement as shown in Table A.

TABLE A

Balcony	850 people × 22.5 c.f.m.	= 19,125
Front orchestra	700 people × 22.5 c.f.m.	= 15,750
Rear orchestra	550 people × 13 c.f.m.	= 7,125
Standees	100 people × 20 c.f.m.	= 2,000
	Total	44,000 c.f.m.

This subdivision is arbitrary to some extent and based on experience. It provides for the delivery of less air per person to the rear orchestra section on the assumption that part of the quantity delivered to the front orchestra returns across the rear orchestra section and is effective in producing the desired result. These quantities as proportioned form the basis for the design of the outlets.

Any arrangement at the conditioner is applicable to this system and for this example, assume that part of the air for the supply is to be drawn from the house, that recirculation through the washer is to be used and that enough outside air is to be drawn in to keep a pressure on the interior. It is not considered good practice to draw less than 7½ c.f.m. per person from outside. The outside air quantity then is:

$$2200 \times 7\tfrac{1}{2} = 16{,}500 \text{ c.f.m.}$$

This is nearly 38% of the total air handled through the system. This quantity does not fix the size of the outside air connection, however, as this should be made large enough to permit drawing in all air from outside on days when the outside conditions make this advantageous. A velocity of 750 ft. per min. in the outside connection is considered suitable.

The amount of air to be brought back from the house is

$$44{,}000 - 16{,}500 = 27{,}500 \text{ c.f.m.}$$

Of this, enough may be passed through the dehumidifier to permit reaching the dew point, and the remainder by-passed past the washer. As an alternate. all may be passed through the washer. At the time of the peak load with 16,500 c.f.m. being planned as outside air, the return system of piping may not be handling its maximum quantity. This is because it is sometimes desirable to operate the plant with nearly all recirculated air during short periods in the winter when the house is not occupied and while it is being warmed up. If this is done the air quantity being handled through the return ducts is a maximum at this time. To allow for this it is good practice to design the return ducts for more than 27,500 c.f.m. In this example, 33,000 c.f.m. will be used. It is the sum of the recirculated air used during peak operation and the return air used at that time. This arrangement is somewhat arbitrary and empirical. On this basis the air quantities can be retabulated as in Table B.

TABLE B

Outside air	2200 people at 7½ c.f.m.	= 16,500
Return air	2200 people at 2½ c.f.m.	= 5,500
Recirculated air	2200 people at 12½ c.f.m.	= 27,500
Return design quantity		33,000
Supply design quantity		44,000

The dehumidifier is sized on the basis of being able

to handle all the supply air (44,000 c.f.m.) at a velocity not to exceed 650 ft. per min. This makes it possible to pass all the air through the dehumidifier and to subject all of it to the action of the sprays and scrubbers. Use of a velocity as great as 650 ft. increases the frictional resistance but keeps the size of the dehumidifier down.

It is common practice to use both a supply fan and an exhaust fan. The supply fan is sized for handling the full supply of 44,000 c.f.m. and the exhaust fan is on the basis of handling the full return of 33,000 c.f.m. Velocities of 1700 ft. per min. for the supply fan and 1500 ft. per min. for the exhaust fan can be assumed for proportioning and sizing.

The cold outside air in winter makes the use of a preheater necessary. It is commonly sized as being able to heat the air above the dewpoint temperature on the coldest day and when the maximum outside air anticipated at that time is being drawn into the house. This amount is 16,500 c.f.m. in this case, as shown in Table B.

Reheating surfaces are proportioned for raising the temperature of the maximum quantity of air passing over them. In this case, this is the maximum amount of recirculated air, or 27,500 c.f.m., as shown in Table B.

One of the principal economies possible in using this system is in the duct work. This is true partly because of the short length of ducts and partly because the velocities in the duct can be kept high if effective sound absorption is provided. A schedule of allowable velocities is shown in Table C.

TABLE C

Supply Fan	**1700 ft. per min.**
Supply Main	**1700 ft. per min.**
Return Main†	**1500 ft. per min.**
Recirculating Main	**1500 ft. per min.**
Return Grilles	**300 ft. per min. (over free area)***
Heaters	**800 ft. per min.**
By-pass at heaters	**1500 ft. per min.**
Outside air intake	**750 ft. per min.**
Relief to outside	**1500 ft. per min.**
Sound absorbers‡	**1500 ft. per min. (over net area)**

† *The velocity in the return duct depends on the method used for balancing the flow. If a reduction in pipe size is used to add resistance, the velocity through the reduced section may have to exceed 1500 c.f.m. In such cases, 1900 ft. is not considered excessive. Another method is to use dampers to build up the necessary resistance.*

* *50% of the gross area may be taken as "free" in many commercial grille designs.*

‡ *The allowable velocity will depend on the type of sound absorber used. Above is for the use of a flexible type of absorber.*

TABLE 1

RELATION BETWEEN DISCHARGE VELOCITY AND STATIC PRESSURE AT DISCHARGE

Static Pressure, Inches	Velocity, in Ft. per Minute	Static Pressure, Inches	Velocity, in Ft. per Minute
.05	896	.60	3102
.10	1266	.70	3351
.20	1791	.75	3468
.25	2003	.80	3582
.30	2193	.87	3729
.40	2533	.90	3800
.43	2637	1.00	4005
.50	2832	1.25	4478

The relief air duct is provided to lead the return air out of the building at such times as the outside air intake is greater than the amount naturally filtering out. It is provided with dampers which permit adjustment to secure a balance of flow. It is sized on the velocity shown in Table C and to handle about 15 c.f.m. per person at maximum flow. For example, this would be 33,000 c.f.m., providing for the relief of all the air handled through the return ducts when desired.

Sound absorbers can be built in a variety of ways and of a variety of materials. Where ducts are lined with the absorbing materials and where the air stream is split up in passing through the absorber with a flexible material being used, about 10 linear feet of absorber should be provided in both the supply and return mains.

Circulating but a small quantity of air, the ejector method of distribution permits economy of refrigeration capacity. A good rule for estimating is to allow from 45 to 50 tons of capacity per 1000 seats. If a more careful estimate is desired, the quantity can be calculated by the usual methods.

In the arrangement shown in Fig. 1, 9,125 c.f.m. must be provided through the nozzles located under the balcony in order to provide for the seats under the balcony and for the standees (see Table A). This leaves

$$44{,}000 - 9{,}125 = 34{,}875 \text{ c.f.m.}$$

to be supplied through the upper set of nozzles. Fig. 2 shows a schematic arrangement of the supply ducts and nozzles, the quantities flowing in each section and the duct sizes required when computed on the velocities given in Table C. The nozzle sizes shown are determined by the method described later.

TABLE 2

NOZZLE DIMENSIONS FOR THEATERS, STORES AND RESTAURANTS

0.1 IN. STATIC PRESSURE									0.4 IN. STATIC PRESSURE								
C.F.M.	T, Inches	Area, Sq. Ft.	Velocity, Ft. per Min.	L, Inches	Blow, Ft.	B, Inches	Area, Sq. Ft.	Velocity, Ft. per Min.	C.F.M.	T, Inches	Area, Sq. Ft.	Velocity, Ft. per Min.	L, Inches	Blow, Ft.	B, Inches	Area, Sq. Ft.	Velocity, Ft. per Min.
60.	3	.0491	1266.	8	†	4 3/4	.1231	490	125.	3	.0491	2533.	9	†	5	.1364	920
85.	3 1/2	.0668	1266.	9	†	5 1/2	.1650	520	170.	3 1/2	.0668	2533.	10	†	5 3/4	.1840	920
110.	4	.0873	1266.	10	35	6 1/4	.2131	520	220.	4	.0873	2533.	13	35	7	.2673	820
175.	5	.1364	1266.	11	50	7 1/2	.3068	570	350.	5	.1364	2533.	16	50	8 1/2	.3942	880
250.	6	.1964	1266.	12	80	9	.4418	570	500.	6	.1964	2533.	18	80	10	.5454	920
450.	8	.3491	1266.	13	130	11 1/2	.7215	620	900.	8	.3491	2533.	20	130	12 1/2	.8520	1,050
700.	10	.5454	1266.	14	200	14	.1069	650	1400.	10	.5454	2533.	24	200	15 1/4	1.270	1,100

†These nozzles are used for low ceiling blows

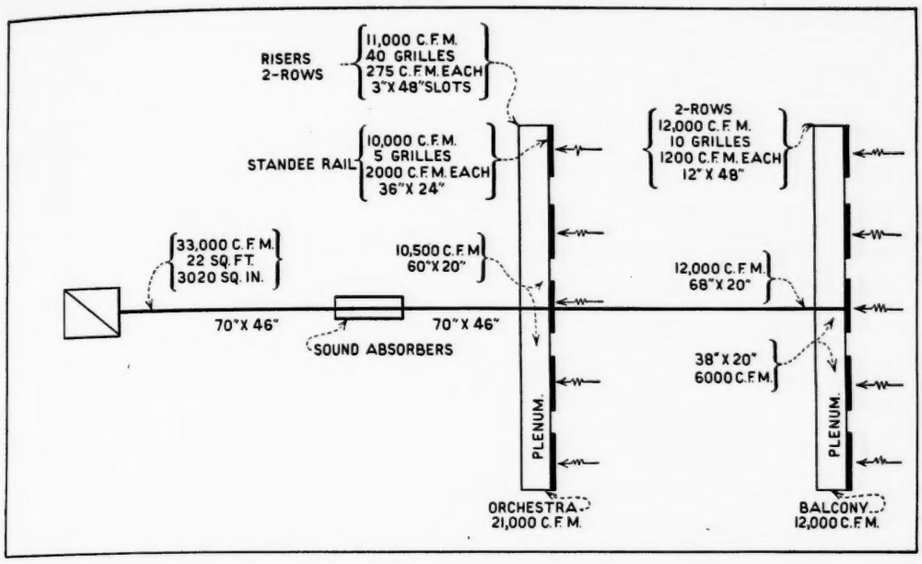


Fig. 3. Schematic diagram of return ducts for the system also shown in Fig. 2.

Fig. 3 is a similar diagram for the sizes and quantities flowing in the return ducts. The duct sizes are also based on the velocities of Table C. The quantity to be removed from the balcony grilles—12,000 c.f.m.—is less than that necessary to be supplied for the balcony seats (see Table A). About 37% of all the air returned through the ducts is removed through the balcony grilles, while the air requirements for the balcony are

$$19{,}125 \div 44{,}000 = 43\%$$

A smaller part of the air is thus being returned than is being supplied. While this is possible, and works, it is interesting to note that in some theaters it is necessary to take a larger proportionate part out through the balcony grilles, in order to prevent balcony spilling of the cool air.

The design of the nozzles for the supply is one of the most important details in connection with this method. Fig. 4 shows the general proportions of such nozzles. The physical size of the nozzle is fixed when the dimensions B, T and L are fixed. The quantity discharged depends on the dimension T and the pressure existing at the tip of the nozzle. As this quantity passes through the opening at a fixed velocity under these conditions, the jet will penetrate into the air a distance which depends on this velocity. The general method of design is, therefore, to use nozzles of such a tip velocity that the air jet will carry to the required distance fixed by the dimensions of the auditorium, and to provide enough of these to permit supplying the desired amount of air.

The velocity produced by a given static pressure can be readily calculated by hydraulic principles. Table 1 shows the velocities corresponding to various pressures. Such a table can be extended to any desired range.

For any of the static pressures shown on Table 1 a table may be readily prepared showing the dimensions B and L for any assured dimension T. A convenient method is to calculate the dimensions by using steps of 1 in. or 2 in. in varying the dimension T. Table 2 is such a tabulation based on the velocities at static pressures of 0.1 in. of water and 0.4 in. of water. Additional tables may be computed readily.

Refer to Fig. 2 and note that the nozzle header supplying the rear orchestra and standees must supply 4563 c.f.m. The length of blow is short and less than 35 ft. Use a static pressure of 0.4 in. water and note (from Table 2) that either the 3 in. or 3½ in. tip

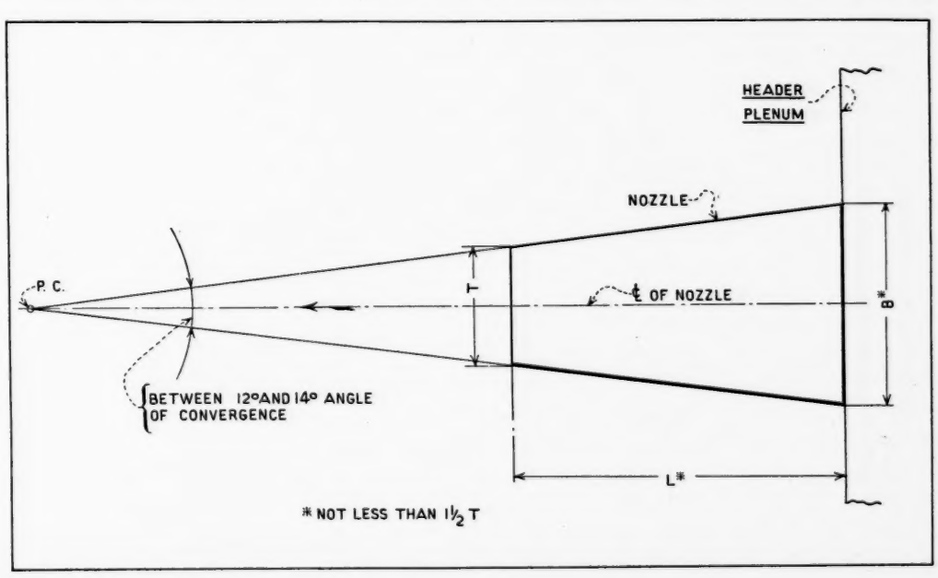
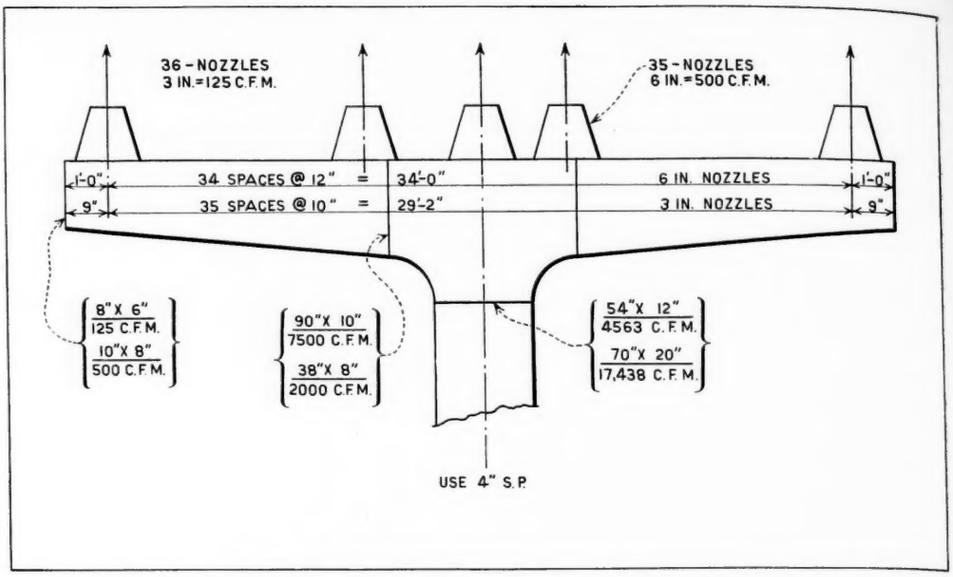


Fig. 4. General proportions of nozzles.

Fig. 5. Dimensions for header in author's example


36 - NOZZLES
3 IN. = 125 C.F.M.
35 - NOZZLES
6 IN. = 500 C.F.M.
1'-0"
9"
34 SPACES @ 12" = 34'-0"
35 SPACES @ 10" = 29'-2"
6 IN. NOZZLES
3 IN. NOZZLES
1'-0"
9"
8" X 6" / 125 C.F.M.
10" X 8" / 500 C.F.M.
90" X 10" / 7500 C.F.M.
38" X 8" / 2000 C.F.M.
54" X 12" / 4563 C.F.M.
70" X 20" / 17,438 C.F.M.
USE 4" S.P.

diameter nozzle is suitable for such a blow. Use the 3 in. Each nozzle under these conditions supplies 125 c.f.m.

$$4563 \div 125 = 36 +$$

Use 36 nozzles. The dimensions will be T = 3 in., L = 9 in., B = 5 in., as noted on Fig. 2. Other nozzles are proportioned by the same method.

When the dimensions of the nozzles and the number required are thus fixed, the principal dimensions of the nozzle header can be determined by spacing the nozzles evenly across the auditorium. Fig. 5 shows the principal dimensions of the header for the example.

Regardless of the care used in the design and construction of the nozzles and headers, uniform distribution of the air is usually not obtained until adjustments are made when trial operation is under way. With suitable adjustments and restrictions which are readily accomplished, practically uniform air flow through all the nozzles results.

A. G. A. Report Indicates Great Activity in Testing of Gas Heating Equipment

THE annual report of the managing committee of the American Gas Association Testing Laboratory, presented at the annual convention of the association in Atlantic City, indicates that the testing of boilers and furnaces during 1931 has increased 37.7% in number over 1930. Under the heading of Appliance Testing, the report of the committee of which J. S. De Hart, Jr., is chairman, states that:

Two hundred and fifty gas appliance manufacturers have submitted all or a portion of their products for laboratory approval. This represents an increase of approximately 5% over last year. As near as can be estimated these concerns produced about 90% of all the domestic gas appliances manufactured and sold in the United States and Canada.

Revenue from laboratory testing activities exceeded the previous fiscal year by about 36%. This fact is attributed largely to a growing appreciation of the value of our approval. The following data indicate the status of the laboratory's appliance approval testing business.

Even more pronounced than the increase in the total number of manufacturers with which the laboratory is doing business was the actual increase in the number of appliances tested. In 1929-30, 1105 appliances were submitted and tested for approval. During 1930-31 this figure rose to 1644, representing an increase of 48.8%.

It is a significant fact that the greatest activity was shown in boiler and furnace equipment, with space heaters a close second. Testing business in the water heater section actually decreased. If these facts are any index of the demand for gas appliances it would seem that most interest is being centered in the house-heating field.

STATUS OF GAS APPLIANCE TESTING

CUMULATIVE TOTAL NO. MFRS. SUBMITTING EQUIPMENT FOR TEST

Type of Appliance	Oct. 1 1928	Oct. 1 1929	Oct. 1 1930	Oct. 1 1931	Percent Increase 1931 over 1930
Gas Range	99	106	124	140	12.9
Space Heater	36	63	88	117	33.0
Water Heater	27	45	59	70	18.7
Boiler and Furnace	45	51	69	95	37.7
Flexible Gas Tubing	8	8	9	9	....
Hot Plate and Laundry Stove	..	5	8	8	....
Clothes Dryer	..	1	2	2	....
Incinerator	..	2	7	7	....
Gas Heated Ironer	..	...	...	1	100.0

Observations on Theater Heating and Air Conditioning

By S. L. GOODWIN†

THE general trend of designing theaters shows an increasing extension of refrigerating for the larger type of buildings and a decrease in this means of cooling for smaller playhouses. A technical representative of a prominent theater circuit told the writer that the added receipts resulting from refrigerated small houses does not warrant the initial cost and upkeep.

Refrigeration must be the eventual method of cooling for even the smallest theaters but the relation of cost to receipts constitutes a challenge to the engineering profession. Meanwhile the engineer should be thoroughly conversant with the elements of cooling by air movement, which must take the place of refrigeration in many instances.

Increased use of refrigeration will depend on lowering the initial cost and overhead. With carbon dioxide plants the cost has been lowered by drastic reduction of the space required for equipment. To save expense, only one fan is now used for both supply and exhaust for the auditorium. This lowers the first cost but raises the expense of upkeep, as the refrigerating plant must be run at all times in summer, even on mild days, if there is a full house, to prevent the recirculated body heat from gradually raising the temperature above the comfort level.

The old horizontal carbon dioxide compressors which were 30 ft. long, with belt drive, have been supplanted by the vertical compressor, 12 ft. long, with direct connected slow speed synchronous motors. The old time double pipe condensers have been succeeded by shell type condensers, with seven water pipes enclosed in one gas shell, occupying one third the space of the earlier models. Today all joints are welded to prevent gas leakage.

The expansion coils of CO_2 machines are also undergoing an evolution. In place of the simple steel coil, the newer equipment is a brass or copper fin type coil, requiring a third of the space of the plain coil. The brass coil assures a longer life, and may be used without the aid of the air washer. Under some humidity conditions, this is an important factor.

Condenser Water

Condenser water is a major item of expense. New York at this time is not allowing city water to be used for refrigerating condensers. Cooling towers or spray ponds must be used to cool condenser water.

Even in communities where street water is allowed, provision should be made for future towers, because at any time the drain on the supply capacity may compel the water company to shut off this source of supply.

Gravity cooling towers are the most efficient for operation, but their unsightliness and bulk often forbid their use. Fan-driven towers are much smaller and of better appearance, but the cost of fan operation must be added to the upkeep. However, in many instances, because of space conditions, particularly in old buildings, the mechanical tower is the only feasible apparatus.

Use of spray ponds is the least expensive method for cooling condenser water. The cost of piping, lower fence enclosure, and treatment of roof to hold water constitute the total expense. No additional weight is added to roof steel load, as the weight of water is not greater than the snow load.

If we are using cooling tower or spray pond water, we may assume its temperature to be 5° above the wet bulb, or 80°. As the critical temperature of CO_2 is 88°, our cooling range is between 80° and 88°, or a maximum of 8°. If we allow a 5° range, each gallon of water will give us 41.66 B.t.u. (one gallon = 8.333 lb. x 5° = 41.66 B.t.u.).

One ton of refrigeration = 200 B.t.u. per min. $\frac{200}{41.66}$ = 4.8 gal. of water per ton. Five gallons per ton is adequate, allowing for the losses normally to be expected.

Of course, if 70° water is used, the amount required will be proportionately smaller.

Winter Heat

Practically no direct radiation is now used in theatre design except for stage and smaller rooms requiring additional heat because of abnormal exposure.

Fans supply every part of the theater with air tempered by blast heaters. Entrance lobbies often have a separate fan, with thermostatically controlled heat, to supply the right amount of air at the necessary temperature to offset the sudden opening of exit doors.

In figuring the required winter heat for an auditorium the writer calculates the wall and roof losses in the usual way in B.t.u., adding to this the heat units required to raise the temperature of the fresh air make-up to 70°, and the loss of heat in the air washer due to cooling by evaporation.

The writer allows 25 c.f.m. per person for auditorium, plus the other losses for lobbies, projection room, toilets, public rooms, and other places. The outside air make-up will vary according to conditions, but the writer usually allows 30% to 33% of the total. A sufficient amount must be supplied to cause a pressure outward

† Consulting Engineer, Office of Thomas W. Lamb, Architect, New York.

to prevent the suction of warm air in summer, or of cold air in winter. Lobbies cannot be kept warm in winter unless there is a pressure outward.

Rooms having exposures proportionally in excess of the auditorium, or of the room in which the thermostat is placed, must have additional direct radiation. Smoking rooms, rest rooms and toilets having exposed walls or roofs should have direct radiation in addition to the fan heat. Also, basement rooms with exposed courts for ceilings will be very cold unless direct radiation is added to the fan heat required for rooms without exposed ceilings. Projection booths and stages should have direct radiation.

Sometimes I am asked to design a plant of the most inexpensive sort for some small theater, with instructions that all the owner wants is a few radiators with no ventilation.

An auditorium seating four hundred or a thousand persons cannot be heated by a few radiators. Usually these houses are in an exposed position, and when all the heat losses are figured, it will be found that a single fan can be installed which will be equally inexpensive.

Plumbing and steam pipe trenches may serve as part of the duct system. The writer considers such a plant infinitely better for such a theater than radiators only, as it will allow sufficient ventilation to remove body odors, and the temperature may be automatically controlled.

If an oversize fan is installed with a variable speed regulator, a small amount of summer cooling may be attained on certain days by a system of damper control which prevents recirculation.

The air supply of an auditorium should be proportioned to the seating. An auditorium should not be considered as one unit, but as three, viz: the front orchestra, the rear orchestra under the balcony, and the balcony. The air supply to each of these three parts, both supply and exhaust, should be in proportion to the seats in each.

The required temperature in each part of the auditorium can be maintained if each part has its correct quota of air. The body heat is removed and an even temperature maintained by the right amount of air. If the rear orchestra is warmer than the front orchestra, it should have more air.

Cooling by Air Movement

When the cost of refrigeration is prohibitive, a limited amount of cooling may be attained by air movement. A cooling effect is sensed by the evaporation of skin moisture when dry air passes over it. The relative cooling effect of air movement is not measured by the changes per hour, but by the velocity of the air. The cooling effect is proportional to the velocity of the air as it strikes the body. Any movement of air cools, but a velocity of 100 ft. per min. is cooler than 50.

Let us assume a theatre auditorium seating 1500 persons, 75 ft. wide by 125 ft. long and 30 ft. high. If the ceiling of this room is 9000 sq. ft. and 90,000 c.f.m. of air is evenly distributed to fall vertically, its velocity will be 10 ft. per min. If the same volume of air can be made to travel horizontally from front to rear it will have a velocity of 40 ft. per min., or four times the vertical velocity. A velocity of at least 100 ft. per min. is desirable in such cases.

Cooling by air movement will be a failure unless the air passes over every seat in the house. As the volume of air required for cooling is two to four times that required for ventilation, architectural considerations make it extremely difficult to handle the air properly.

A reduction of temperature in extreme weather may be attained by use of an air washer, but the resulting high humidity may damage draperies and decorations. Therefore, the range of air washer cooling is limited.

The "talkies" have made noise extremely objectionable. A machinery hum or roar which would not be noticeable with the silent screen, may destroy the audibility of the spoken word. For the same reason any noise is objectionable in the legitimate theater, in vaudeville houses, opera houses or where speech or music is part of the production.

Compressors should not be under the auditorium. If they must be under the auditorium special provision should be made to prevent noise vibrations being transmitted into the theater.

If possible, fans, motors and air washers should not be over the auditorium, but over the lobby or other portions of the building if they must be located above the basement. When they must be over the auditorium, as frequently happens, extreme care must be exercised to prevent machinery noise interfering with stage programs.

Machinery and piping connected with the refrigerating plant are splendid noise producers. Compressor foundations and every steel support of condensers and of spray pond pump and of all piping to and from pump and compressors should be carefully insulated. When any of this apparatus comes in unprotected contact with floors, walls or structural steel, noise vibrations may be transmitted that may cause heavy expense to locate and remove.

A. G. A. Reports Gain in Gas Heating

THE Report of the House-Heating Committee of the American Gas Association, presented at the annual convention of the association in October, contains statistical data as to the number of gas-fired systems in use, prepared in its usual excellent form by the statistical department of the association. The data show that the number of gas-fired central heating systems increased 30.64% from July 1, 1930 to July 1, 1931.

The accompanying table shows the data summarized in some detail. It is important to note two points. The first is that the totals include about 5000 radiant heating jobs which properly should not be included, and the second is that the data are only for the companies reporting, numbering 118 manufactured gas utilities and 31 natural gas companies.

Making allowance for the radiant heating jobs, as noted in the table, the total number of gas-fired central heating plants known to be in use is 107,589. Of these 36,734 are using manufactured gas and 70,855 natural gas. These figures are, of course, constantly shifting, due to the change over from manufactured to natural gas in some localities, and too, do not allow for the number of jobs installed since July 1.

It will be noted that there are in use 75,173 straight gas-designed jobs and 32,146 converted installations. An examination of the data will also reveal that, in comparing the number of installations made last year with the number already on the lines before that time, in manufactured gas territory the tendency is for the proportion of conversion installations to increase and for straight gas designed installations to decrease. In natural gas territory this tendency is reversed.

In the summary, presented in the accompanying table, it will be noticed that there are a few discrepancies, amounting to about two hundred installations. This is not due to errors in the data as originally reported, but was made necessary in condensing the data to a short table without numerous footnotes. The committee's report, as presented, is greatly detailed, by company name, sub-totaled by state, further subtotaled by type of gas used, etc. The data do not include gas-fired unit heaters, radiators and other space heaters.

GAS-FIRED CENTRAL HOUSE-HEATING INSTALLATIONS†

(Abstracted and slightly rearranged from the A.G.A. House-Heating Committee Report)

	Mfd. Gas	Natural Gas
Total number customers (all kinds) served, 1931	6,966,965	1,055,464
Number of central gas heating systems per 1000 customers	5.98	66.87
Total installations, central heating, gas-fired, July 1, 1930	38,135(a)	47,788
Ditto, July 1, 1931	41,667(b)	70,855
Increase, per cent	9.26	47.70
Steam, Hot Water and Vapor Installations		
Straight gas-designed, 1930	18,246	1,588
Straight gas-designed, 1931	21,779	2,140
Increase, per cent	19.36	34.76
Conversion, 1930	1420	1653
Conversion, 1931	2371	3888
Increase, per cent	66.97	135.21
Total, 1930	19,666	3241
Total, 1931	24,150	6028
Increase, per cent	22.80	85.99
Warm-Air Heating Installations		
Straight gas-designed, 1930	17,740(a)	34,542
Straight gas-designed, 1931	16,367(b)	39,820
Increase, per cent	.....	15.28
Decrease, per cent	7.74	.....
Conversion, 1930	729	10,005
Conversion, 1931	1150	24,737
Increase, per cent	57.75	147.25
Total, 1930	18,469	44,547
Total, 1931	17,517	64,557
Increase, per cent	.....	44.92
Decrease, per cent	5.15	.....
Total Gas-Designed Jobs—1930	35,986(a)	36,130
Total Gas-Designed Jobs—1931	38,146(b)	41,960
Total Converted Jobs—1930	2149	11,658
Total Converted Jobs—1931	3521	28,625

†Dates given are as of July 1, 1930 and July 1, 1931.
(a) Includes 5570 radiant heating jobs.
(b) Includes 4933 radiant heating jobs.

A Drafting Room Kink

THE problem often arises in the drafting room of tracing a drawing in which the draftsman dare not push a thumb tack. Paper clips do not hold the tracing paper and original together tightly, and glue or paste leaves the drawing and tracing in a messy condition.

For such cases it is extremely handy to have available a roll of Scotch decorator's tape which can be purchased at decorators' and photographic supply shops for about twenty-five cents. The tape is easily torn and resembles adhesive tape in that it grips the surface well. However, the decorator's tape has the advantage of leaving no sticky mark whatever, the sticky surface remaining on the tape. For this reason it can be used over and over again. This characteristic is probably what gave the tape its name.

Another use for the tape is for cases where it is desired to trace a small drawing on which the draftsman wishes to work at all angles. The drawing and tracing can be clamped together with the tape and moved around all over the board at any angle, facilitating lettering in difficult positions. Too, if the work is to be taken home the drawings can be carried home together, with the two pieces held firmly in the same relative positions, thus eliminating the drudgery of re-tacking the papers to the board.

Use of small tabs of the tape enables the draftsman quickly to hang the drawing against the wall to dry after inking it.

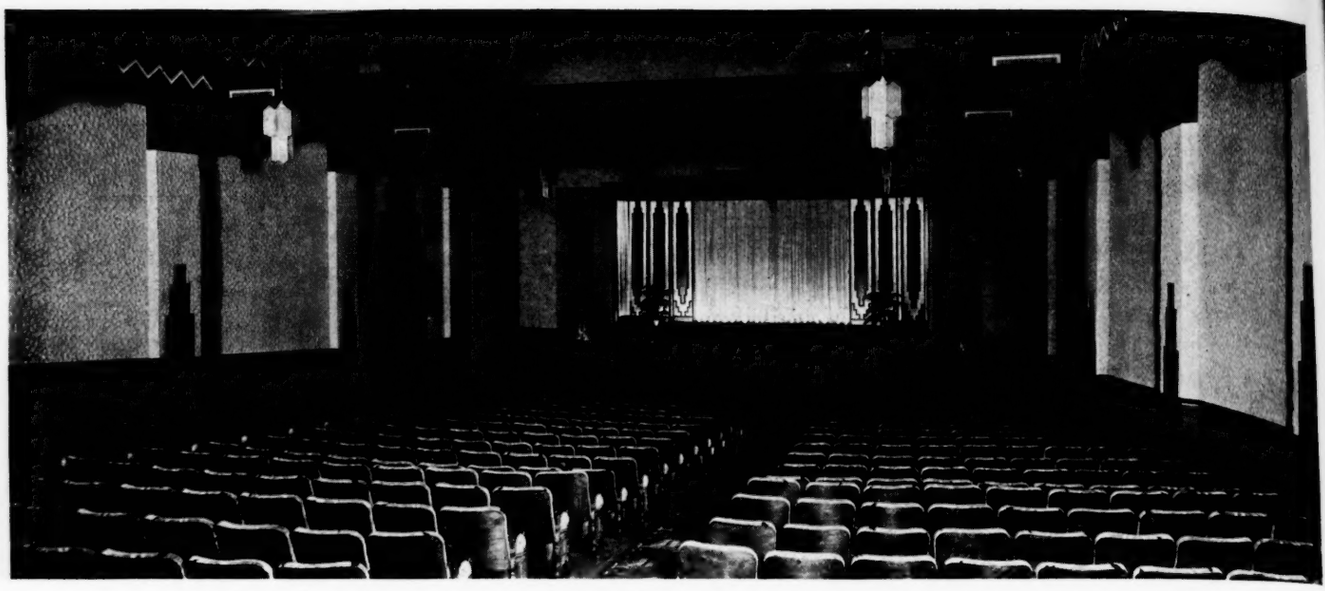


Fig. 1. Interior of the Waldo Theater. Air inlet openings in the ceiling can be seen.

Ice Used to Cool Kansas City Theater†

ICE for theater cooling is no new development in point of time. Some of the early cooling plants were designed for its use. Fig. 5 shows a plant which was installed in the Royal Theater, Kansas City, in 1914. The plant was planned for both heating and cooling. The vento stacks ahead of the washer are so arranged

† Based on information furnished by Miner D. Woodling, Kansas City, Mo.

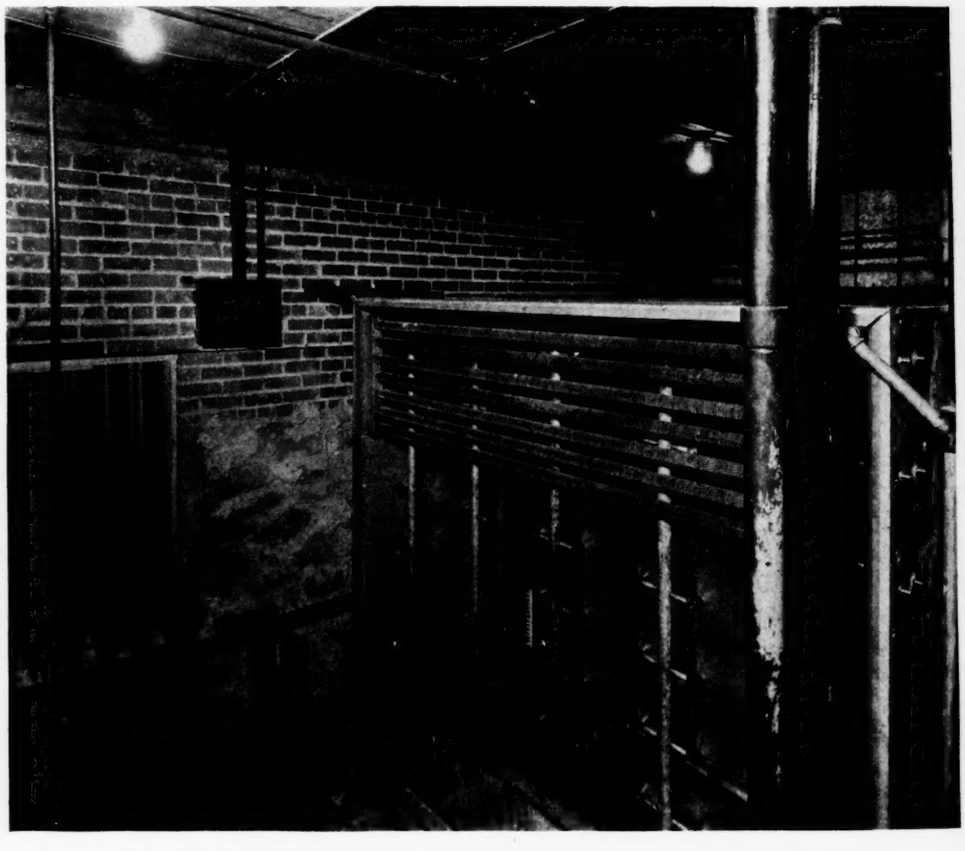


Fig. 2. The air washer in operation.

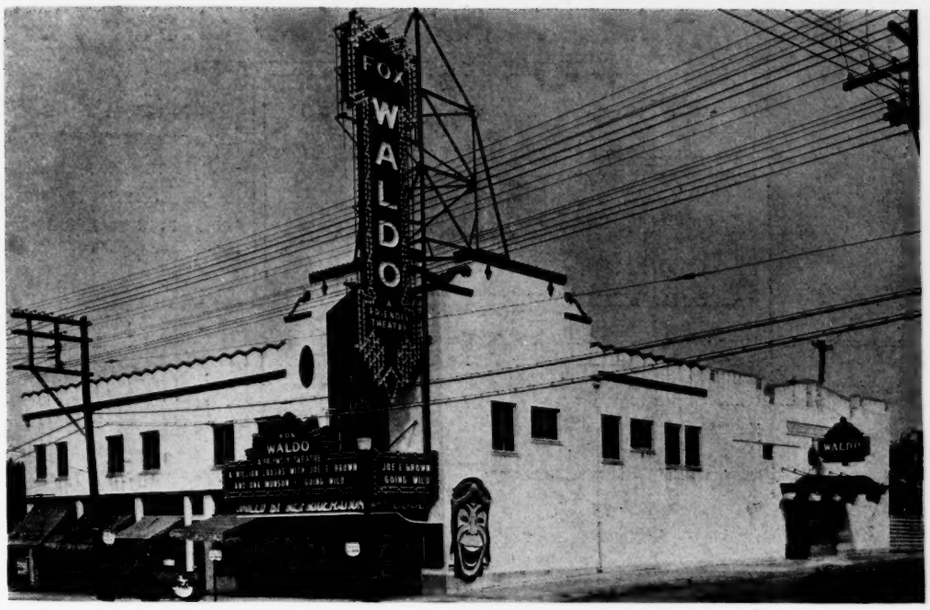


Fig. 3. Exterior of the Waldo Theater, a medium-sized house.

that the reheating of the air may be controlled in winter. Provision for the use of ice consisted of two large doors on the side of the washer casing through which 300 lb. cakes of ice could be introduced into the water pan. This ice cooled the water which was then pumped back through the sprays of the washer and served to cool and dehumidify the air as it passed through. It is also interesting to note that this plant contains provision for by-passing part of the air around the washer, and that it makes use of return air drawn back to the fan from the conditioned space. Both of these features have since come into wide use. Ice at that time was too costly to make the installation profitable at the low admission price then charged.

Recently, with ice available at lower rates, with higher admission prices and a greater demand for cooling, ice for this purpose has again come to the front. A number of installations have been made in several cities. Among these is the one in the Waldo Theater, Kansas City, Mo.

Fig. 3 shows a view of the theater exterior which is of moderate size, seating slightly over 1000. Evening shows are given daily and afternoon shows are run both Saturday and Sunday. The plant uses a washer of standard design and is arranged for recirculation and by-passing. A view of the ice piled inside the

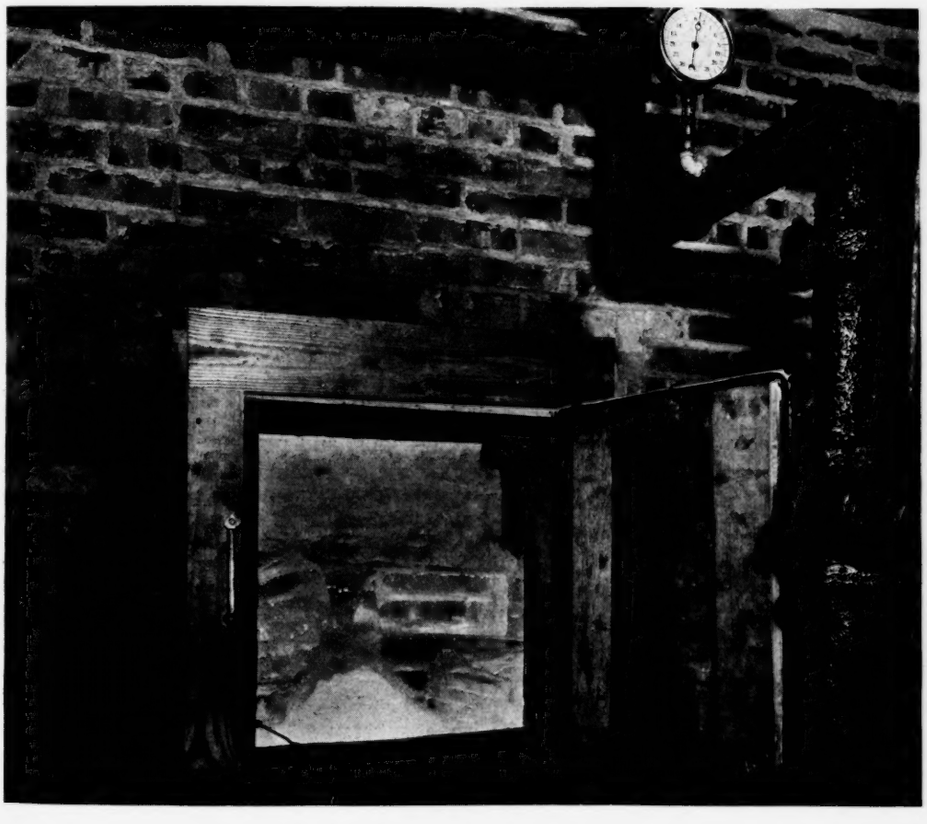


Fig. 4. Looking into the ice bunker at the pile of ice blocks over which water is sprayed.

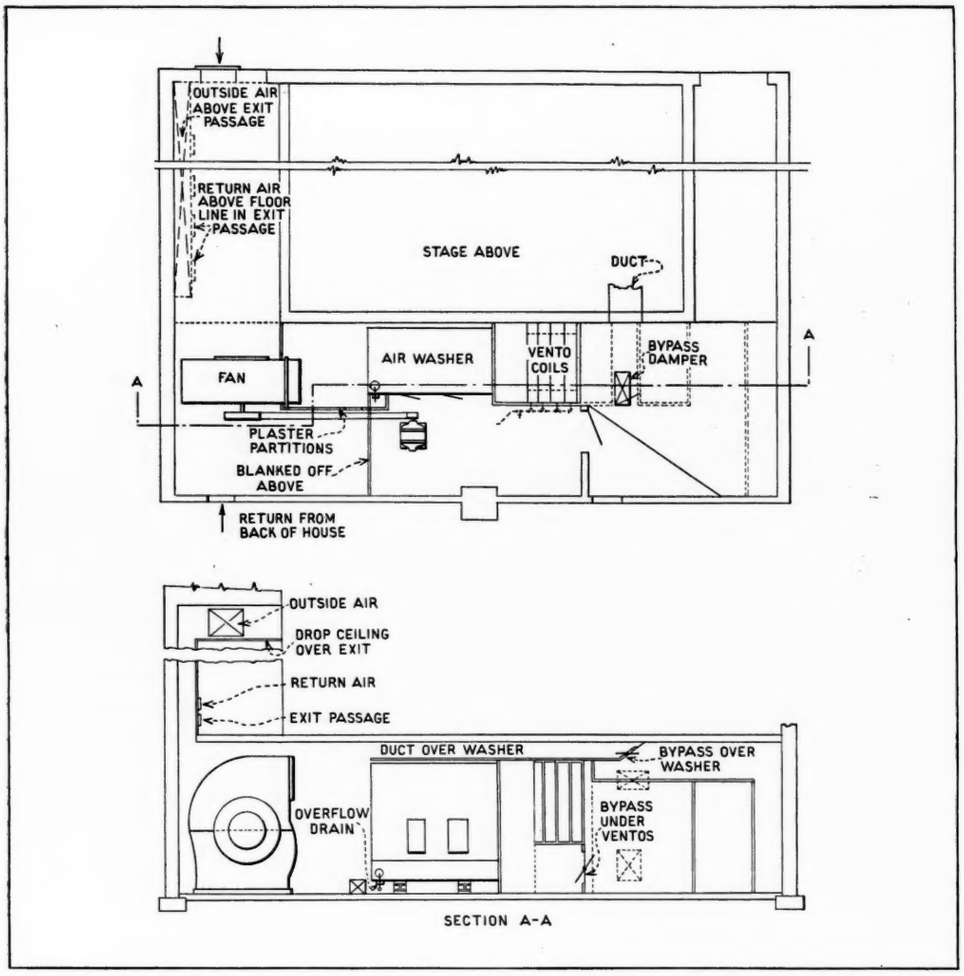


Fig. 5. Plan and elevation of the installation made in 1914 at the Royal Theater, which provided for putting ice into the bottom of the washer.

bunker is presented, while Fig. 2 shows the air washer. The method of melting the ice follows the general plan shown in Fig. 1, page 50.

The temperature of the water in the washer is automatically controlled in normal operation by the wet bulb, while the dry bulb is thermostatically controlled by cutting off the cold water supply to the washer when the dry bulb is lowered to the thermostat setting.

The distribution method used is of the downflow, or cross type with the air admitted through slots at the ceiling. The return air is withdrawn at the rear of the auditorium, partly above the floor line, but with most of it being removed at the floor.

The plant was finished in time to operate during August and September, 1931. During part of this period the outside dry bulb reached 102° with a wet bulb of 76°. The plant was operated to carry 80° dry bulb and 68° wet bulb in ordinary operation. During the two-month period the plant maintained the desired conditions successfully, and did so with an average ice consumption of 0.6 tons of ice per hour of operation. During the period the outside dry bulb ranged from 80° to 100°.

At the time of the dry bulb of 102° referred to, a capacity test was made to see how low a temperature could be reached. With an audience of approximately 800 the plant succeeded in bringing the inside temperature to 72° dry bulb with 55% relative humidity.

Fire Protection Rules for Heating Film Rooms†

Heating Equipment

Artificial heating in any building or room, other than a vault, in which motion picture film is used, handled or stored, shall be restricted to steam not exceeding 10 lb. pressure or hot water, provided, however, that this shall not be construed as prohibiting the installation of an indirect system employing high pressure steam when the radiators or heating coils of such system are not located in the room or rooms to be heated. Heat generating apparatus shall be in a separate room.

Note: Ordinary warm-air furnaces are prohibited. Gas, oil and electric heaters are prohibited in rooms where film is handled or stored.

All steam pipes within 6 ft. of the floor, and where passing through partitions or racks or near woodwork, shall be covered with approved pipe covering. All radiators, heating coils, and pipes and returns that are near the floor or are so located as to permit any combustible material, waste or dirt to come in contact therewith shall be guarded and protected by means of ¼ in. mesh galvanized steel wire cloth No. 20 B. & S. gauge, or by its equivalent. The bottom of such guards shall be arranged so as to lift up for cleaning purposes and the tops to slope so that guards cannot be used as shelves. Guards shall be so constructed that no film can come within 4 in. of the heating surface, and shall be made with a substantial metal frame work which will prevent the wire mesh being forced against the radiator or pipes.

† From the Report of Committee on Hazardous Chemicals and Explosives, Proceedings of Thirty-Fifth Annual Meeting, National Fire Protection Association, Toronto, Canada, May 11-14, 1931.

Methods of Air Distribution in Theaters

Fig. 1. Interior of the Logan Theater in Philadelphia, showing the grille work through which air is introduced into the auditorium.

THE effect of the most careful and painstaking processing of air at a central conditioner in a theater is of little working value unless the air is so distributed over the occupied part of the auditorium that it accomplishes its end purpose in actually passing across the bodies of the occupants in such quantities, with such properties, and at such velocities as to really result in a comfortable feeling. It is thus easy to lay down the desired result; to succeed in actually accomplishing it is a difficult matter and little exact or fully reliable information is at hand.

Several principles seem to be established. One is that it is not necessary to make provision for control of both the entering and leaving air. It is contended that control of distribution can be adequately secured at either entrance or exhaust if care is taken. A second principle is that the air quantity should be proportioned to the seating distribution. A third is that balcony and mezzanine circulation should be provided separate from the orchestra space. A fourth is that the air should move toward the faces of the audiences.

Regardless of these principles the actual securing of the desired distribution is still almost wholly empirical. Construction peculiarities must be taken into account. So must the fact that the same means used for distributing cool air in summer are used for handling warm air in winter. Actual applications have tended to become more or less standardized into several "systems."

Before describing the principal features of these it is well to note that once the air leaves the enclosing ductwork it is very largely "free" and to a considerable extent will move in accordance with its density relative to surrounding air. It is relatively difficult to cause it to move otherwise. Therefore, methods of distribution-control which depend on exhaust pull of fans usually attempt to take advantage of the natural flow and locate their exhaust openings where the return air can reach them without depending on the fan pull any more than necessary. The fan pull can be used as a final means of adjustment and the openings are often made adjustable.

As air leaves supply openings its travel can be influenced to some extent by giving it velocity in a definite direction, as well as by controlling its quantity and temperature properties. The travel of the air can probably be more influenced from the point of supply than from exhaust points because of these facts. They are also taken advantage of in methods which largely depend on control at the supply.

Several Methods for Introducing Air Are Available

In introducing the supply air several methods are in use. One is to introduce the air through a few large openings at low velocity. Another is to introduce it through a multitude of small openings. A third is the use of pan type diffusers which are often built into

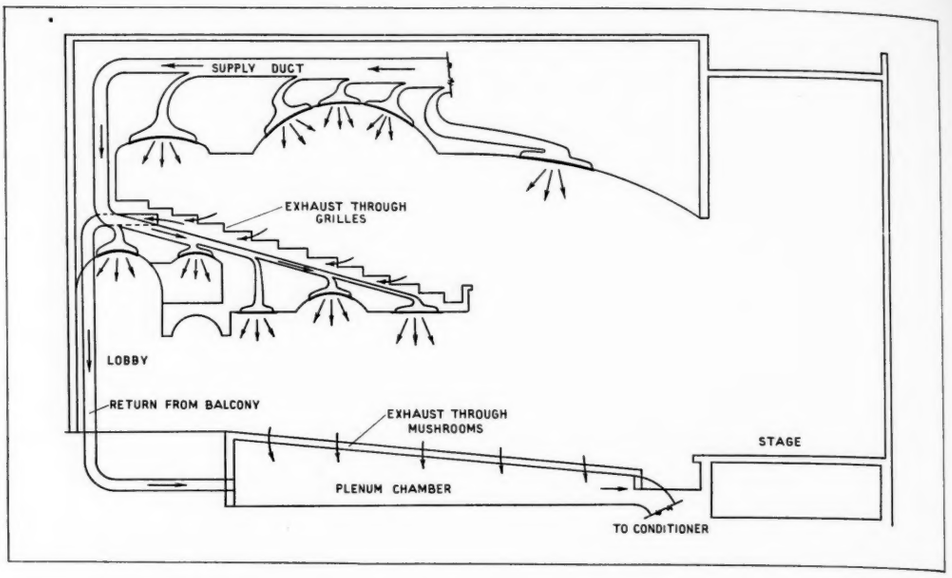


Fig. 2. A method of air distribution in which air is introduced at the ceiling and discharged through many distributed floor openings and through the balcony to a plenum chamber.

lighting fixtures. A fourth is to use high velocity jets.

Methods of exhaust remove the air at the main floor line or through ducts built under balconies and mezzanines. If removed at or near the main floor line, it may be taken through a great number of small openings distributed over the auditorium, or through a few relatively large openings usually located toward the rear of the orchestra space. It is usually necessary to provide for removal at the balcony levels in addition to the provision made at the main floor. Air is removed either from above the balcony floor or from below it in some of the methods now in use.

The use of high velocity jets or nozzles is described and illustrated in the article on page 52 of this issue. The figures there given make the idea clear.

Fig. 3 shows a method of distribution which is sometimes called cross ventilation. The supply ducts are designed for low velocity and the air is fed or spilled into the main auditorium through large openings located near the stage. One current sweeps over the orchestra space while another sweeps the balcony. As the air temperature rises from coming in contact with the audience, the air tends to rise, moves up the inclined floors and is removed from under the balcony and from the ceiling. Control is obtained largely through adjustments of the exhaust.

Fig. 2 shows diagrammatically a method of distribution in which the air is fed through openings located in the ceiling and removed from a multitude of openings located in the floor. It is also possible to modify this method so that all the outlet openings can be located in or near the main aisles. In this method the outlet velocity at the supply openings is small and the natural drift of the air is depended on to bring it to the exhaust openings.

A modification of the general method shown in Fig. 2 introduces the air through floor openings instead of exhausting through them. Installations are reported where the flow is reversed between winter and summer operation.

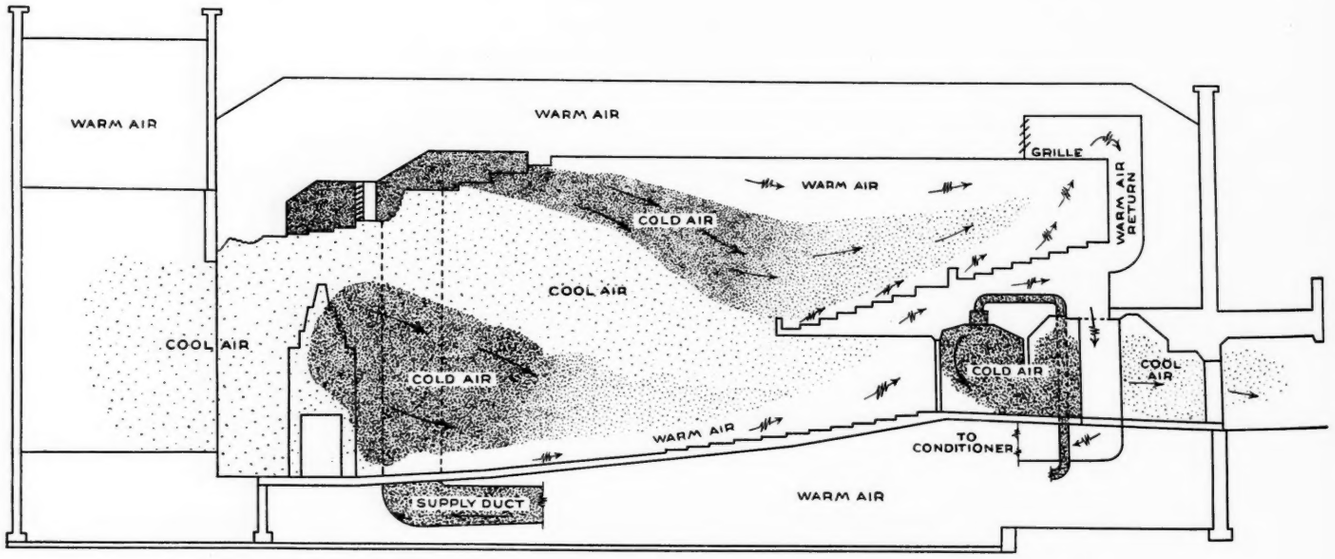


Fig. 3. A cross flow method of distribution. Air is spilled into the room and withdrawn from the ceiling above the balcony and from the balcony ceiling to a plenum exhaust passage.

Air Quantities and Recirculation in Air Conditioning‡

By M. G. HARBULA†

PRESENT practice in air conditioning is to use recirculated air. Its use brings problems which have not been fully discussed.

In the early plants all the air handled through the system was taken from outside. In this case, if 30 cu. ft. per person per minute were handled it was all outside air and resembled in this respect the older fan-and-duct heating and ventilating installations. Recirculation as an economy measure, especially during heating-up periods, and during periods when the space was unoccupied, was often practiced in these heating and ventilating plants. Gradually the idea of recirculating part of the air in air conditioning plants also came into use as an economy measure. It should be noted, however, that in the case of air conditioning plants the recirculation is practiced not only during times of heating up or when there is no occupancy, but is often deliberately practiced during periods of occupancy. As a result, present practice in comfort conditioning leans strongly toward bringing in from the outside only a part of the air to be handled through the system and securing the remainder by using over again the same air which has been passed over the occupants in the conditioned space.

In order to show more clearly the relation of air quantities to size of plant, arrangement and capacities of equipment and the employment of return or recirculated air, figures and detailed examples will be used to describe all the various functions involved. Some of the methods shown are restricted from general use by patents already granted or pending, while others are not.

Each method of handling the air at the washer has peculiarities of its own, and the heat exchanges are different in each case. These can be analyzed in general terms, and formulas can be set up whereby calculations can be made. Instead of giving general formulas, however, we will illustrate by a problem.

> ***Problem:*** **A certain space to be comfort conditioned must have removed from it 3740 B.t.u. per min. and 10,208 grains of moisture per minute in order to maintain 78° dry bulb, 68° wet bulb, 60% relative humidity, and a 63° dew point against an outside temperature of 95° dry bulb and 75° wet bulb; 4313 c.f.m. of outside air are to be admitted into the system when the temperature outside is at the maximum.**

In the problem certain factors common to all the several methods of handling the recirculated air have been omitted for simplicity. The procedure to be followed in determining quantities, while less accurate to a slight degree than if these factors were included, will demonstrate in a practical manner the author's remarks and calculations. The problem illustrates a standard comfort cooling job and could be applied to a theater, restaurant, bank, and commercial or industrial office building. Separate solutions have been made to determine the principal quantity items when using different methods of handling the air at the conditioner.

In order to bring the principal results of these several solutions together Table 1 has been prepared. It makes the comparative figures available at a glance. Since peak operating conditions are assumed the figures in the table are the ones on which equipment and sizes will be based. The figures also furnish information on which the methods involved may be discussed critically. The example numbers in the table are the same as used in drawings throughout the article.

Fig. 1 shows the arrangement of equipment and routing of air when the amount of air handled by the plant has been determined on the basis of the heat and moisture increment within the cooled space, regardless of spread, or rise, of temperature of air between the point of introduction and room temperature. Example

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† Consulting air conditioning engineer, Glen Ellyn, Ill.

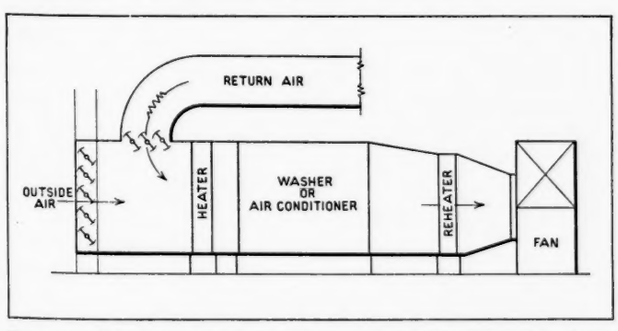


Fig. 1. Simple arrangement; air quantity determined on basis of heat and moisture added in conditioned room.

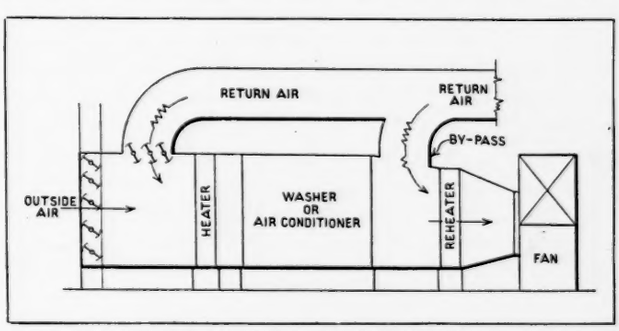
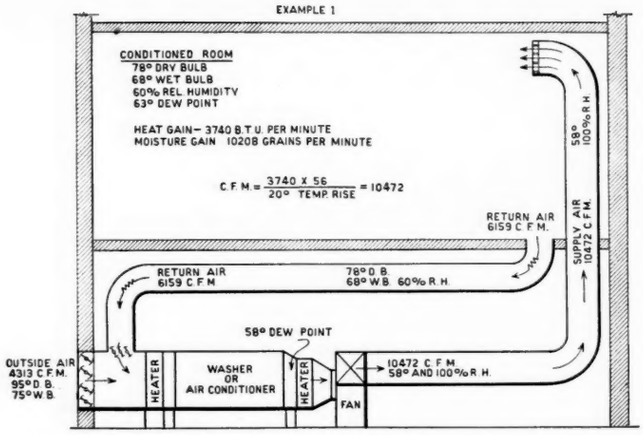
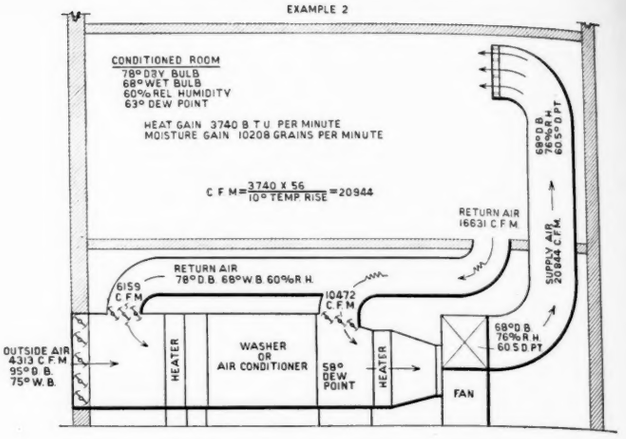


Fig. 2. Arrangement of split system.


EXAMPLE 1
CONDITIONED ROOM
78° DRY BULB
68° WET BULB
60% REL. HUMIDITY
63° DEW POINT
HEAT GAIN- 3740 B.T.U. PER MINUTE
MOISTURE GAIN 10208 GRAINS PER MINUTE
C.F.M. = 3740 X 56 / 20° TEMP. RISE = 10472
RETURN AIR 6159 C.F.M.
SUPPLY AIR 10472 C.F.M.
58° 100% R.H.
RETURN AIR 6159 C.F.M.
78° D.B. 68° W.B. 60% R.H.
58° DEW POINT
OUTSIDE AIR 4313 C.F.M. 95° D.B. 75° W.B.
HEATER
WASHER OR AIR CONDITIONER
HEATER
FAN
10472 C.F.M. 58° AND 100% R.H.


EXAMPLE 2
CONDITIONED ROOM
78° D.B.
68° WET BULB
60% REL. HUMIDITY
63° DEW POINT
HEAT GAIN 3740 B.T.U. PER MINUTE
MOISTURE GAIN 10208 GRAINS PER MINUTE
C.F.M. = 3740 X 56 / 10° TEMP. RISE = 20944
RETURN AIR 16831 C.F.M.
68° D.B. 76% R.H. 60.5 D.PT.
SUPPLY AIR 20944 C.F.M.
RETURN AIR 78° D.B. 68° W.B. 60% R.H.
6159 C.F.M.
10472 C.F.M.
OUTSIDE AIR 4313 C.F.M. 95° D.B. 75° W.B.
HEATER
WASHER OR AIR CONDITIONER
58° DEW POINT
HEATER
68° D.B. 76% R.H. 60.5 D.PT.
FAN

Calculations for Example 1

REFRIGERATION

Outside air—4313 c.f.m. = 300 lb. from 75° w.b. to 58° w.b.
= 300 lb. × (37.81—24.88)* = 3879 B.t.u. per min.

Return air—6159 c.f.m. = 445 lb. from 68° w.b. to 58° w.b.
= 445 lb. × (31.92—24.88) = 3132 B.t.u. per min.

Total heat to be removed from air = 7011 B.t.u. per min.

Rate of refrigeration per 24 hrs. = 35.05 tons.

CO_2 refrigerating compressor displacement (30° suct.—86° condensing) = 0.6324 cu. ft. per ton per min.

CO_2 refrigerating compressor capacity (30° suct.—86° condensing) = 35.05 tons × 0.6324 = 22.17 c.f.m.

DEW POINT

Dew point of air in room—63°.

Absolute humidity at 63°—6.4 gr. moisture per cu. ft.

Moisture increment in room— $\frac{10208 \text{ gr. per min.}}{10472 \text{ c.f.m.}} = 1.0$ (approx.) gr. moisture per cu. ft.

Absolute humidity of air entering room = 6.4—1.0 = 5.4 gr.

Dew point corresponding to 5.4 gr. per cu. ft. = 58°.

*Figures in parentheses are total heats.

Calculations for Example 2

REFRIGERATION

Outside air—4313 c.f.m. = 300 lb. from 75° w.b. to 58° w.b.
= 300 lb. × (37.81—24.88)* = 3879 B.t.u. per min.

Return air—6159 c.f.m. = 445 lb. from 68° w.b. to 58° w.b.
= 445 lb. × (31.92—24.88) = 3132 B.t.u. per min.

Total heat to be removed from air = 7011 B.t.u. per min.

Rate of refrigeration per 24 hrs. = 35.05 tons.

CO_2 refrigerating compressor displacement (30° suct.—86° condensing) = 0.6324 cu. ft. per ton per min.

CO_2 refrigerating compressor capacity (30° suct.—86° condensing) = 35.05 tons × 0.6324 = 22.17 c.f.m.

DEW POINT

Moisture in conditioned air—10472 c.f.m. at 58° Dew point (5.4 grs. abs. hum.) = 10472 × 5.4 = 56458 gr.

Moisture in return air—10472 c.f.m. at 63° Dew point (6.4 grs. abs. hum.) = 10472 × 6.4 = 67020 gr.

Total amount of moisture in air entering room = 123478 gr.

Grains moisture per cu. ft. air entering room = $\frac{123478 \text{ gr.}}{20944 \text{ c.f.m.}} = 5.9$ gr.

Moisture increment in room— $\frac{10208 \text{ gr.}}{20944 \text{ c.f.m.}} = 0.5$ gr. (Approx.)

Absolute humidity of air in room = 5.9 + 0.5 = 6.4 gr.

Dew point corresponding to 6.4 gr. abs. hum. = 63°.

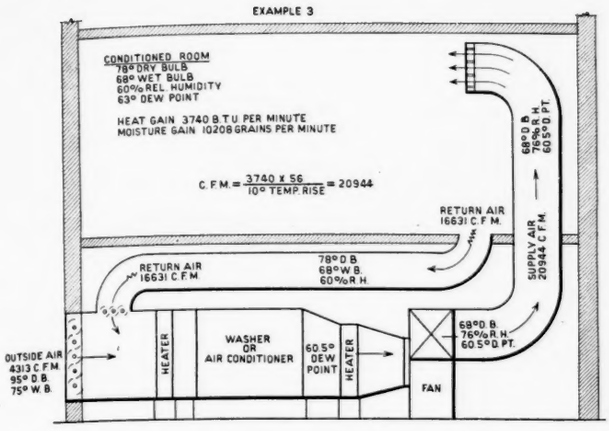
*Figures in parentheses are total heats.

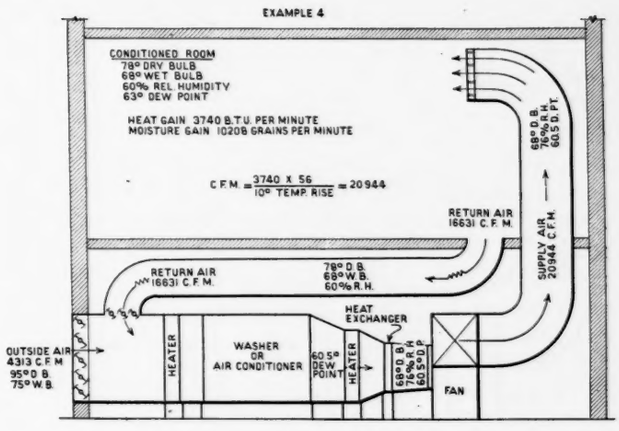
1 details the calculations involving determinations of air quantities, dew points at conditioner, amount of refrigeration required, and other items, when this method is applied to the problem just stated. In this method, all the air which is to be passed to the conditioned space has the benefit of coming in contact with the water in the spray chamber, and is subjected to its influence and to whatever deodorizing and cleansing virtues this water and the eliminator plates may have.

While some of the air passed to the room has been used before, it is all washed. At the period of peak conditions in summer 40% (4313 c.f.m.) of all the air passed to the room is air which has never before been passed over the bodies of the room occupants while 60% has been so passed. At all other times during the summer the amount of outside air may be increased up to 100% of the fan capacity, depending upon the wet bulb temperature, without exceeding the capacity of the refrigerating plant. The total amount of air circulated is 10,472 c.f.m. and with the amount of heat to be absorbed in the room the rise in dry bulb temperature of the air is 20° as it passes through the conditioned space. The plant could be designed with a 30° spread, or temperature rise, with a resultant smaller air handling plant throughout, lower first cost and lower operating cost. However, to do this, careful designing of the air distributing system is necessary. With this arrangement, no reheating of the air after it leaves the washer is necessary. It will be noted that a refrigeration effect of slightly over 35 tons is required.

If the amount of air to be handled by the plant is prescribed by local ordinances calling for 30 cu. ft. of air per person, or its equivalent in cubic feet of air per square foot of floor area, and if this amount is greater than actually required for the absorption of the total heat and moisture increment in the conditioned room, or if by reason of the designer's lack of knowledge or experience to design a distributing system for greater than a 10° temperature rise, a greater amount of air is decided upon than noted in Example 1, then a number of methods of coping with the problem are open to the designer.

Fig. 2 shows one method in use. Example 2 which applies the problem hereinbefore to this method shows that the additional amount of air prescribed beyond the actual requirements of the problem as shown in Example 1 is obtained by returning it from the room and passing it directly to the fan which redelivers it to the room, the return air acting throughout the cycle as ballast. It will be noted in Fig. 2 that the path of the air returning to the system is split. Part of it, namely 6159 cu. ft. (see Example 2) enters the mixing chamber ahead of the washer. This is the amount brought to the same point in Example 1, where it is mixed with the outside air. The same amount of outside air is used in both Example 1 and Example 2. In Example 1, no more air is added to the system, a total of 10,472 cu. ft being sufficient. In Example 2,


EXAMPLE 3
CONDITIONED ROOM
78° DRY BULB
68° WET BULB
60% REL. HUMIDITY
63° DEW POINT
HEAT GAIN 3740 B.T.U. PER MINUTE
MOISTURE GAIN 10208 GRAINS PER MINUTE
C.F.M. = 3740 x 56 / 10° TEMP. RISE = 20944
RETURN AIR 16631 C.F.M.
SUPPLY AIR 20944 C.F.M.
68° D.B. 76% R.H. 60.5° D.PT.
RETURN AIR 16631 C.F.M.
78° D.B. 68° W.B. 60% R.H.
OUTSIDE AIR 4313 C.F.M. 95° D.B. 75° W.B.
HEATER
WASHER OR AIR CONDITIONER
60.5° DEW POINT
HEATER
FAN
68° D.B. 76% R.H. 60.5° D.PT.


EXAMPLE 4
CONDITIONED ROOM
78° DRY BULB
68° WET BULB
60% REL. HUMIDITY
63° DEW POINT
HEAT GAIN 3740 B.T.U. PER MINUTE
MOISTURE GAIN 10208 GRAINS PER MINUTE
C.F.M. = 3740 x 56 / 10° TEMP. RISE = 20944
RETURN AIR 16631 C.F.M.
SUPPLY AIR 20944 C.F.M.
68° D.B. 76% R.H. 60.5° D.PT.
RETURN AIR 16631 C.F.M.
78° D.B. 68° W.B. 60% R.H.
HEAT EXCHANGER
OUTSIDE AIR 4313 C.F.M. 95° D.B. 75° W.B.
HEATER
WASHER OR AIR CONDITIONER
60.5° DEW POINT
HEATER
68° D.B. 76% R.H. 60.5° D.P.
FAN

Calculations for Example 3

REFRIGERATION

Outside air—4313 c.f.m. = 300 lb. from 75° w.b. to 60.5° w.b.
= 300 lb. × (37.81—26.51)* = 3390 B.t.u. per min.

Return air—16631 c.f.m. = 1200 lb. from 68° w.b. to 60.5° w.b.
= 1200 lb. × (31.92—26.51) = 6492 B.t.u. per min.

Total heat to be removed from air = 9882 B.t.u. per min.
Rate of refrigeration per 24 hr. = 49.41 tons.
CO_2 refrigerating compressor displacement (32.5° suct.—86° condensing) = 0.6087 cu. ft. per ton per min.
CO_2 refrigerating compressor capacity (32.5° suct.—86° condensing) = 49.41 tons × 0.6087 = 30.08 cu. ft. per min.

DEW POINT

Dew point of air in room—63°.
Absolute humidity at 63°—6.4 gr. moisture per cu. ft.

Moisture increment in room—$\frac{10208 \text{ gr. per min.}}{20944 \text{ c.f.m.}}$ = 0.5 gr. (approx.)

Absolute humidity of air entering room = 6.4 — 0.5 = 5.9 gr.
Dew point corresponding to 5.9 gr. per cu. ft. = 60.5°.

STEAM REQUIRED (SUMMER REHEATING)

To heat 20944 c.f.m. (1596 lb.) from 60.5° to 68° or 7.5°
1596 × 7.5 × .241 = 2872 B.t.u. per min.
= 2.87 lb. steam per min.
= 172 lb. steam per hr.

*Figures in parentheses are total heats.

Calculations for Example 4

REFRIGERATION

Outside air—4313 c.f.m. = 300 lb. from 75° w.b. to 60.5° w.b.
= 300 lb. × (37.81—26.51)* = 3390 B.t.u. per min.

Return air—16631 c.f.m. = 1200 lb. from 68° w.b. to 60.5° w.b.
= 1200 lb. × (31.92—26.51) = 6492 B.t.u. per min.

Total heat to be removed from air = 9882 B.t.u. per min.
Rate of refrigeration per 24 hr. = 49.41 tons.
CO_2 refrigerating compressor displacement (32.5° suct.—71° liquid) = 0.4465 cu. ft. per ton per min.
CO_2 refrigerating compressor capacity (32.5° suct.—71° liquid) = 49.41 tons × 0.4465 = 22.06 c.f.m.

DEW POINT

Dew point of air in room—63°.
Absolute humidity at 63°—6.4 gr. moisture per cu. ft.

Moisture increment in room—$\frac{10208 \text{ gr. per min.}}{20944 \text{ c.f.m.}}$ = 0.5 gr. (approx.)

Absolute humidity of air entering room = 6.4 — 0.5 = 5.9 gr.
Dew point corresponding to 5.9 gr. per cu. ft. = 60.5°.

REHEATING—(SUMMER)

from 60.5° (at washer outlet) to 68° (room inlet) by means of liquid refrigerant
Heat of liquid at 86°—45.45 B.t.u. per lb. CO_2
Heat of liquid at 71°—25.67 B.t.u. per lb. CO_2
Available for heating—19.78 B.t.u. per lb. CO_2
2.70 lb. (CO_2 required per ton per min. at 32.5° suct., 71° liquid) × 19.78 = 53.41 B.t.u.
53.41 × 2.35 (tons per 1000 c.f.m. circulated) = 125.51 B.t.u. per 1000 c.f.m.

$\frac{125.51}{74 \text{ lb. (1000 c.f.m.)} \times .241 \text{ (sp.ht. of air)}}$ = 7.04° plus 0.46° (added by condenser water) = 7.5°

Temperature of air delivered to room = 60.5° + 7.5° = 68°.

*Figures in parentheses are total heats.

20,944 cu. ft., or 100% more, is supplied to the room. The difference—10,472 cu. ft.—is air returned directly from the room which by-passes the washer or conditioner, meeting the air issuing from this equipment before it is all picked up by the supply fan for delivery to the room again.

Two points about this arrangement are especially noteworthy. First, the air which enters the stream after being by-passed is exactly the same air which has just passed through the conditioned room. It has not been mixed with any outside air until it enters the mixing chamber just ahead of the fan. Here it mixes with the air which has just been passed through the conditioner. As before, the air leaves the conditioner at or near saturation. Its temperature is normally lower than the temperature of the air entering through the by-pass connection. The second point to be noted is that the effect of mixing these two quantities of air is to raise the dry bulb temperature of the processed air while that of the by-passed air is lowered until an equilibrium temperature is reached in the mixture. It is thus clear that the by-passed air can be used to add heat to the air which passes through the conditioner and it should also be clear that the addition of this heat is necessitated by the use of air quantities greater than the problem actually requires. Consider Examples 1 and 2 in this connection. In Example 1, 10,472 cu. ft. of air, all passed through the conditioner and cooled therein to 58°, is supplied to the room to absorb 3740 B.t.u., this heat increasing its temperature 20°. In Example 2, 100% more air is supplied to the room, making it necessary in the same problem to have available 100% more heat. However, since there are but 3740 B.t.u. available in the room, it is necessary to cool one-half of the total amount of air handled to 58°, and add the remaining one-half at room temperature beyond the conditioner to supply the additional 10° of heat, for the 20,944 cu. ft. will increase only 10° in dry bulb temperature during its passage through the room.

Comparison of the methods shown in Fig. 1 and Fig. 2 and their respective examples is interesting. The total amount of air in Fig. 2 is double that used in Fig. 1. The design of the distribution is easier but the sizes of ducts, fans and motors are increased if velocities are to be kept the same in each case. The amount of outside air brought in is the same in Example 1 as in Example 2 during the peak period. It represents but 20.6% of the total amount handled in Example 2 instead of 41.2% as in Example 1. In Example 2 the refrigeration effect required to cool the air is the same

as in Example 1 but the total amount of refrigeration necessary in Example 2 is greater since the fan and motor input is greater.

One interesting point in connection with the operation of a plant using the method of Example 2 should not be overlooked. The washer is intended to handle only about 50% of the total air circulated through the system. At times in summer, spring or fall when the outside air is cool, enough cannot be brought in through the washer to supply the total quantity even if the by-pass damper is closed. Therefore, some air must be recirculated and by-passed.

Example 3 makes use of the same arrangement at the washer as does Example 1, but the air quantity used is 100% more, or the same as Example 2. All the air is passed through the sprays. In this case, however, since double the amount of air is being handled to extract the same amount of heat and moisture in summer, it is necessary to reheat the air between the point at which it leaves the washer and the point of its introduction into the room. In this solution the reheat is added by the use of a steam coil inserted into the path of the air stream as it leaves the washer. The same amount of outside air is drawn into the system at the time of the peak load as in the other solutions. Under these conditions the refrigeration capacity required to cool the air is 49.4 tons instead of the 35.05 tons necessary in Examples 1 and 2. In addition to this, 172 lb. of steam must be used per hour to supply the reheat. This increase of 14 tons in refrigerating capacity and 172 lb. of steam per hour, as well as the increase in first cost and operating costs due to the use of larger fans and motors than in Example 1, can be considered as chargeable to the greater quantity of air used.

In so far as comparison with the method in Example 2 is concerned, all the air supplied to the room in Example 3 passes through the conditioner; in Example 2, only 50% passes through the conditioner in peak periods and less at other times.

The method detailed in Example 4 is another that may be used when the air supply is based upon a 10° temperature rise, or 30 c.f.m. per occupant or its equivalent. Exactly the same procedure is followed as in

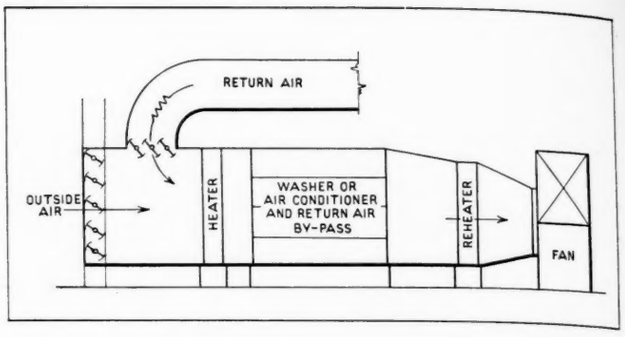


Fig. 3. Arrangement used when more air is circulated than is needed to absorb moisture and heat in conditioned room.

Example 3, up to the point where the air leaves the conditioner at 60½° and requires reheating to 68°. The method and means used to reheat the conditioned air is one invented by the author a few years ago. It consists essentially of heating the air by waste heat from the refrigerant, either in gas, liquid or vapor form, or with water from the refrigerant condensers or with a combination of either, the choice depending upon various factors in the installation, the amount of reheat required, the reduction in refrigerating compressor capacity desired, or final results wanted. However, the most important advantage of the method shown in Example 4 is that it requires a refrigerating plant of less capacity with a smaller driving motor and lower operating costs. This is due to the fact that the refrigerant in giving up its heat to the air is being cooled itself. The resultant sub-cooling of the refrigerant increases its useful refrigerating effect accordingly, thus requiring a refrigerating machine with smaller capacity to produce the same final effect in the cooled space.

In Example 4, as in Example 3, a refrigerating effect of 49.41 tons per 24 hr. must be applied to cool the air; the difference in the two methods being the size or capacity of the refrigerating equipment required to produce this cooling. It might be well to point out that in both of these methods the air is cooled to 60½° in the air conditioner while in Example 2 the air must be cooled to 58° due to the fact that less air is con-

TABLE 1

Example	1	2	3	4
Dry bulb temperature of air in room, °F.	78	78	78	78
Relative humidity of air in room, %	60	60	60	60
Temperature difference or spread bet. air entering and room, °F.	20	10	10	10
Dry bulb temperature of air entering room, °F.	58	68	68	68
Relative humidity of air entering room, %	100	76	76	76
Dew point temperature of air entering room, °F.	58	60.5	60.5	60.5
Dew point temperature of air leaving washer, °F.	58	58	60.5	60.5
Total amount of air circulated, c.f.m.	10472	20944	20944	20944
Amount of outside air introduced, c.f.m.	4313	4313	4313	4313
Percentage of outside air to total, %	41.2	20.6	20.6	20.6
Amount of air returned and conditioned, c.f.m.	6159	6159	16631	16631
Amount of air returned and not conditioned, c.f.m.	None	10472	None	None
Refrigerant suction temperature, °F.	30	30	32.5	32.5
Refrigerant liquid temperature, °F.	86	86	86	71
Refrigerating effect per lb. CO_2, B.t.u.	54.65	54.65	54.31	74.09
Compressor displacement, cu. in. per ton per min.	1093	1093	1052	772
Refrigerating effect required to cool air; tons per 24 hr. rate	35.05	35.05	49.41	49.41
CO_2 to be compressed to produce refrigerating effect to cool the air and upon which the size of refrigerating equipment is based; c.f.m.	22.17	22.17	30.08	22.06

ditioned. This immediately suggests that refrigerant evaporating temperatures in the cooling coils may be increased 2½°, resulting in higher suction pressures, less horsepower per ton, as well as smaller compressor displacement capacity. Using CO_2 as the refrigerant and with the refrigerant cooled to a condensing temperature of 86° in a standard double pipe condenser, and by-passing this liquid through a coil in the path of the conditioned air and in heat exchange relation with it, it may be readily sub-cooled to a temperature of 71° by the 60½° air available, which incidentally would be heated to a temperature of 67.5°. The mean temperature difference is approximately 14.35° and this heat exchange is readily accomplished with a minimum amount of the highly efficient heat transfer apparatus now available. Since 68° air is required in this problem, the additional ½° rise may be obtained by passing a small quantity of the warm condenser water, always available, into the heater, present in practically all cases. When necessary a separate heater may be provided.

In Example 4, with a suction gas temperature of 32.5° and a refrigerant liquid temperature of 71°, the refrigerating effect per pound of CO_2 is 74.09 B.t.u., the compressor piston displacement necessary is 0.4465 cu. ft. or 772 cu. in. per ton per minute, the amount of CO_2 to be compressed is 49.41 tons x 0.4465, or 22.06 cu. ft. per min.

In Example 2, the suction gas temperature would be 30° as explained, and with a refrigerant liquid temperature of 86°, the refrigerating effect per pound of CO_2 is 54.65 B.t.u., the compressor displacement necessary is 0.6324 cu. ft., or 1093 cu. in. per ton per minute, the amount of CO_2 to be compressed is 35.05 tons x 0.6324, or 22.17 cu. ft. per min., slightly more than required in Example 4.

In Example 3, the suction gas temperature would be 32.5°, the same as in Example 4, and with a refrigerant liquid temperature of 86°, the refrigerating effect per pound of CO_2 is 54.31 B.t.u., the compressor displacement necessary is 0.6087 cu. ft., or 1052 cu. in. per ton per minute, the amount of CO_2 to be compressed is 49.41 tons x 0.6087, or 30.08 cu. ft. per min. This is 26.3% more than required in Example 4 and 26.6% more than in Example 2.

Sub-cooling the liquid refrigerant by means of the author's method as explained for Example 4, from 86° to 71°, the heat available for raising the temperature of the conditioned air is 19.78 B.t.u. per lb. of CO_2. Since 2.70 lb. of CO_2 are required per ton per minute in this problem, the heat available is 2.70 x 19.78, or 53.41 B.t.u. per ton. With 49.41 tons refrigerating effect required to cool the 20,944 cu. ft. of air per minute circulated in the cooling plant, the tons required per 1000 c.f.m. are: $\frac{49.41}{20.944} = 2.35$, and 2.35 x 53.41 (B.t.u. available per ton) = 125.51 B.t.u. per 1000 c.f.m. The temperature rise of the air is, therefore,

$$\frac{125.51}{74 \text{ lb. x } 0.241 \text{ (sp. ht. of air)}} = 7.04°,$$

where the 74 lb. is the weight of 1000 cu. ft. of air. With air leaving the air conditioner at 60½° and heated to: 60.5° + 7.04° = 67.54° by means of the warm liquid refrigerant, it is still necessary to add approximately ½° to the air to bring it to the 68° at which temperature it is to be delivered to the room to maintain the 78° required. This ½° may be added as explained.

Examples 2, 3 and 4 are all alike in that they are based on the use of about 30 cu. ft. per person per minute to be handled. They are, therefore, alternate solutions, any of which may be selected if 30 cu. ft. are required either because of code or ordinance requirements or because of the preference of the designer. However, Examples 3 and 4 differ from Example 2 in that, in the former two, all air handled by the plant passes through the conditioner. In Example 2, only a fraction of the air is treated in the conditioner, the rest passing back into the room without being processed unless filters, ozonizers, ionizers, etc., are introduced into the return lines. These three solutions, in other words, differ from each other in that the methods used to reheat the air before it enters the fan, vary in each case.

Fig. 3 illustrates another method that may be used when more air is circulated than required to absorb the heat and moisture emitted in a space to be cooled, or the same amount of air circulated in Examples 2, 3 and 4. According to the description of the patent covering this method and sketches illustrating it, this method is similar in effect to that shown in Fig. 2 and detailed in Example 2, in that the excess air required is passed into the circulating system direct from the room into the fan and back into the room without conditioning or processing. The washer or air conditioner is partitioned, forming several compartments, parallel to the flow of air, each compartment being equipped with water sprays which are turned on or off, partly or entirely, by the functioning of pre-set automatic regulating equipment, to produce a condition of air suitable to maintain the desired temperature and humidity in the room. The obvious difference in the two methods is that in the one shown in Fig. 3, all of the air returned from the room is mixed with outside air before entering the conditioner, while in the method shown in Fig. 2, part of the return air enters the conditioner with the outside air, while the rest of the return air by-passes the conditioner entirely and enters the fan direct. In both, return air is permitted to enter the supply system without processing or conditioning. With the same amount of outside air, return air, and total amount circulated, and treating or conditioning but part of the return air, the refrigeration requirements for the method shown in Fig. 3 must be the same as for the method shown in Fig. 2, regardless of the fact that all the return air is mixed with the outside air in the former.

Still another method uses the same arrangement of equipment as is shown in Fig. 1, but using different spraying apparatus at the conditioner. Instead of producing a fine mist constantly, which occurs in conditioners in common use, the inventor of this method claims that by varying the size of the water droplets produced by the spray apparatus, it is not necessary to reduce the air to the temperature of its dew point,

and then reheat it in order to compensate for the excess amount of air circulated. Incidentally, this method is one which also may be used when more air is circulated than necessary, such as when the air capacity is based upon a low temperature rise, 30 c.f.m. per occupant or its equivalent when based upon cubic feet per minute per square foot of floor area. While the author has not had an opportunity to test this method for refrigeration tonnage required to cool the air, calculations which the author examined indicate that the same amount of refrigeration effect is required, as in Examples 1 and 2. The calculations were made by the inventor and they involved substantially the same problem as outlined in the examples given in this article. However, this method uses less water for spraying purposes than does a standard mist type conditioner, resulting inevitably in colder water temperatures being used, thus requiring suction temperatures in the refrigerating cycle lower than shown in Examples 2, 3 and 4. Lower suction temperatures are reflected in greater compressor piston displacement due to the necessity of compressing a greater volume of refrigerant and the horsepower per ton is increased. An advantage of this method over that shown in Fig. 2 is that all the air circulated in the system passes through the conditioner.

Careful study of all these methods now in use for handling the air at the washer is desirable on the part of anyone who wishes to put himself in a position to intelligently select apparatus and make recommendations. Such a study will reveal significant differences in the several methods both as regards equipment costs and operating costs.

Study of the methods and the figures will also bring out several important points.

First of all, they show clearly the effect of the quantity of air being handled and the temperature rise upon the plant capacity. Does it not seem that every effort should be strained to promote the use of methods which will permit of introducing the air at as great a temperature difference as possible?

Next, the methods described all make use of air over and over again. Obviously, all the air cannot be so used for even if *all* of it is passed through a water spray, odors cannot be removed indefinitely. Where but a part of the air comes in contact with the spray water does not the odor question become increasingly important? Obviously also, there must be some lower limit beyond which recirculation of air cannot be practiced. Where does this limit lie? Can it be found and definitely predicted?

In closing this article the writer feels that he should state emphatically that while air conditioning is quite desirable and gives much promise, there are still many points which are well worth careful attention. There has been too much of a tendency for all of us to take too many of the technical questions for granted, and to accept conclusions without full and analytical examination of the elements. Much of this is because of the prevalent lack of information on the subject.

Test Data on B & M Ice Cooled Cars

TABLES 1 and 2 show the conditions existing and the results obtained in the B. & M. Railroad ice cooled coach. A description of the car was published in HEATING AND VENTILATING for November.

It will be noted that in the first test with outside dry bulb temperatures ranging from 77° to 85°, dry bulb temperatures on the inside ranged from 66° to 77°, with an average ice consumption of 290 lb. per hr.

In the second test with the outside dry bulb temperatures ranging from 80° to 92°, the inside dry bulb temperatures ranged from 71° to 80°, with an ice consumption of 418 lb. per hr.

TABLE 1.

TEST DATA ON BOSTON & MAINE COACH, SEPTEMBER 9, 1931
(Temperatures and times: ice consumption = 290 lbs. per hour)

Time	10.00	11.00	12.00	1.00	2.00
Train started 9.30; cooler at 9.47					
Outside, wet bulb	65	66	72	76	75
dry bulb	77	80	82	80	85
Other car, dry bulb	68–70	70–72	72–85	75–80	75–83
Center test car, wet bulb	57	59	62	62	63
(7 ft. 6 in. up) dry bulb	65	67	71	72	73
Front conditioner, air entering car, wet bulb	48	48	55	56	57
Front conditioner, air entering car, dry bulb	52	52	60	60	60
Front conditioner, air entering cooler, wet bulb	58	63	64	65	66
Front conditioner, air entering cooler, dry bulb	68	75	74	76	76
(Rear conditioner gave closely similar results).					
Level of passengers' heads, dry bulb					
Left front	70	70	74	76	77
Left center	67	66	70	73	74
Left rear	70	70	74	76	77
Other side closely similar.					

TABLE 2.

TEST DATA ON BOSTON & MAINE COACH, SEPTEMBER 10, 1931
(Temperatures and times: ice consumption = 418 lbs. per hour)

Time	10.00	11.00	12.00	1.00	2.00
Train and cooler started at 9.00					
Outside, wet bulb	72	75	75	76	77
dry bulb	80	85	85	90	92
Other car, dry bulb	82	87	91	92	98
Center test car, wet bulb	60	60	67	64	65
(7 ft. 6 in. up) dry bulb	71	71	78	76	78
Front conditioner, air into car, wet bulb	57	60	56	55	57
Front conditioner, air into car, dry bulb	60	63	60	58	60
Front conditioner, air into cooler, wet bulb	64	65	68	66	67
Front conditioner, air into cooler, dry bulb	73	74	78	79	79
(Rear conditioner similar)					
Level of passengers' heads, dry bulb	73	73	80	78	80
Left front	..	..	..	..	..
Left center	71	71	78	76	78
Left rear	73	74	80	80	80
(Other side similar)					

Abstracts . . .

Reviews and Summaries of . . . . Current Papers, Books and Pamphlets

Design of Gas Burners for Domestic Use

Circular of the Bureau of Standards, No. 394, issued July 10, 1931, 21 pages, illustrated, 6 in. x 9 in. Obtainable through the Superintendent of Documents. Price 10 cents.

General information regarding the action of, and the most favorable design for, burners of the type commonly used in domestic and some industrial appliances with gas as a fuel. The information is largely based on experimental work, the results of which have been reported previously by the bureau. The circular aims to put much of this into more convenient form than did the older reports.

After describing the action of a Bunsen burner and the phenomena which occur in the Bunsen flame, the desirable characteristics of a burner are discussed. It is shown that it is necessary for the designer to sacrifice, to a limited extent, some of these characteristics in order to improve the burner in other respects. The effects of various modifications in details of construction are then given, and the reader is supplied with approximate formulas and some general advice which may be used as a guide in designing or modifying a burner for a particular set of conditions of service.

A summary at the end sets down eleven steps in the design of a burner, giving them in the approximate order in which they should be taken, and referring to the descriptive material of the circular.

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Surface Coefficient as Affected by Direction of Wind

By F. B. Rowley and W. A. Eckley

An A.S.H.V.E. paper resulting from a study conducted at the University of Minnesota in cooperation with the research laboratory of the society. Approximately 1200 words, 1 table, two graphs, and photographs.

Specimens were mounted in the path of the discharge from a fan, the speed of which could be varied and controlled. The specimens were so mounted that their angle with the path of the air stream could be adjusted at will from a position at right angles to the stream to a position parallel with the stream. Suitable means of measuring the heat was provided. The two variables under control were thus the angular direction of the air stream relative to the surface and the velocity of the stream. The temperature of the air was kept substantially steady throughout the tests. Air speeds were varied up to about 30 m.p.h.

The change in the value of the surface coefficient with the change in the angular relation of the surface to the wind does not appear of great enough significance to warrant introducing changes into the values used for practical purposes. Values obtained with parallel flow may be used without change on account of angularity.

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Importance of Radiation in Heat Transfer through Air Spaces

By E. R. Queer

A.S.H.V.E. paper, about 2500 words, 10 figures, 4 tables, one drawing showing testing set-up.

Describes tests made by the Engineering Experiment Station of the Pennsylvania State College and presents and summarizes the resulting data.

The author states that the factors affecting radiation in confined air spaces are the emissivity of the surfaces and their temperatures while those affecting convection and conduction in such spaces are the height and width of the spaces and the conductivity of the enclosed fluid. The tests were intended to separate these factors to determine their relative effect on heat transmission.

Three series of tests are mentioned in the paper as follows:

1. To determine the emissivity.
2. To show how the conductance of vertical air spaces varies with the width of the space.
3. To measure the effect on the insulating value when keeping the width constant and varying the height from 4½ in. to 35 in.

Measurements of the heat resistance of the air spaces were made by the electric hot plate method. The apparatus was so arranged that a known quantity of heat was passed across an air space with the surface temperatures of the enclosing bodies measured. The effect of the nature of the surface was found by using bright aluminum for the surfaces and by covering the surfaces with lamp black. The conductance of the space was greatly less at a given mean temperature difference when both surfaces were covered with bright aluminum foil than when both surfaces were blackened. Curves presented in the paper show that with a mean temperature of 70° the conductance of a one-inch air space with bright aluminum foil on both surfaces is nearly 0.5 B.t.u. per sq. ft. per hr., while the same space when

bounded by black surfaces has a conductance of about 1.24 B.t.u. per sq. ft. per hr. The value of the bright metallic surfaces in reducing the heat transferred by radiation is thus clearly shown. The data collected permitted the author to calculate the amount of heat transferred by radiation. Subtracting this from the total amount of heat gave the amount transferred by other methods.

When the width of the space was varied in the second series of tests the author found that ¾ in. spacing, i.e., with a width of air space of ¾ in., the conductance became a minimum when the vertical space height was from 9 in. to 11⅝ in.

The third series of experiments in which the height was varied shows that with air spaces 1 in. wide, the conductance decreases as the height of the air space is increased up to about 35½ in. This is contrary to the belief generally held but the results of the test show it clearly. The author explains what apparently takes place in blocking off the vertical height of the space is that increasing the height increases the surface frictional resistance to air flow. Convection is decreased and resistance to air flow increased.

The author also shows by computations applied to several building walls that when his data are applied to the air spaces, approximately 75% of the total heat passing across the space is carried by means of radiation. He also states that where multiple bright thin metallic surfaces are placed in the air space the best spacing is 0.37 in.

The author lists the following conclusions:

1. Plain bright metallic surfaces form an excellent heat insulation by reducing radiant heat transfer.
2. Insulation made up of such surfaces is usually very low in density, and is not seriously affected by moisture.
3. The optimum insulation spacing for a single air space is about 0.75 in.
4. The optimum insulation spacing for multiple air spaces is 0.37 in.
5. Increasing the height of a thin air space up to 35 in. increases the resistance to heat flow.
6. With conventional building materials about 75% of the total heat transmission across enclosed vertical spaces is by radiation.

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Output of Heating Units at Various Temperatures

By E. A. Allcut

A.S.H.V.E. paper, about 3500 words, 13 figures and graphs, 13 tables.

The author supervised tests made in the Mechanical Engineering Laboratory of the University of Toronto under the auspices of the School of Engineering Research, using radiators enclosed in an adjustable enclosure and with the radiators heated by both steam and hot water. The heating units tested included three- and six-column direct cast iron units, aluminum units containing expanded surfaces or fins, copper tubes expanded into aluminum fins, cast iron fin units, bent copper tubes with pressed sheets clamped and welded to them, copper or brass tubes with special type soldered fins. Each was tested using both steam and hot water at various temperature differences between the medium and the air. Each was installed in an enclosure as recommended by its manufacturer.

Results are stated in terms of B.t.u. transmitted per hour at the various temperature differences. Curves presented in the paper show the numerical results obtained. In nearly every case the heat output obtained in the test when using hot water as a medium was less than when using steam at the same temperature.

The author's apparatus consisted of placing the unit to be tested in front of a screen and with the unit inside its enclosure. A gas-fired heater was used to either heat hot water or to generate steam. When hot water was used it was supplied to the heater from a constant head tank. The heated water then passed through the unit being tested, the rate of flow being regulated by a valve at the outlet.

Where steam was used provision was made for dry steam by inserting a separator in the feed line.

The author summarizes his results as follows:

1. The output of a gravity convector (concealed radiator) varies with the area of the air inlet which may be too large to give the best efficiency.
2. The best form of stack is that with vertical sides. Increasing the area at the top may reduce the output considerably.
3. When placed under a window, down draft and consequent inefficiency may be avoided by putting the air outlet in the front of the enclosure instead of at the top.
4. The heat output with hot water is usually less than that expected from steam tests. The amount of loss appears to depend more on the disposition of the direct heating surface than on the relative amounts of direct and indirect surface. It may also bear some relation to the finish of the surface, whether bright or dull.
5. The distribution of air across the outlet is seldom uniform. In most cases the greatest velocity is obtained on that side of the heating unit at which the steam or water enters. Most of the air is emitted from the top three or four inches of the outlet slot or grille.
6. The difference between the temperatures of the direct and indirect heating surfaces were generally less than 1°, except in one case, where consistent differences of 1½° to 2° were observed. It follows that if the direct heating surface is the more efficient, this is probably due to the fact that in most cases the air flow is perpendicular to the direct heating surface and parallel to the indirect heating surface.
7. The coefficient of heat transmission varies considerably in heating units used as gravity convectors, but generally the higher ratios of hot water to steam outputs are obtained with the surfaces that are lightly loaded from a heat transmission standpoint.

News of the Month

A. S. M. E. Pure Air Committee Publishes Its Objectives

The Pure Air Committee of the American Society of Mechanical Engineers, recently organized from the A.S.M.E. Fuels Division committee on smoke abatement and atmospheric pollution, has made public the following declaration of its policies:

1. The pure air committee is organized under the authority and sponsorship of the American Society of Mechanical Engineers in recognition that the elimination of atmospheric pollutants is essentially an engineering problem.

2. It is a central body through which all matters of air clarification or contamination touching upon or involving engineering responsibility, may be cleared, and before which all opinions on these subjects, technical or otherwise, may be aired. It is contemplated that in due time the pure air committee will become the recognized authoritative body and its meetings a forum for the discussion of pure-air problems by all those variously interested, or whose points of view are interlocked with, and related to, the air purification problem.

3. The committee will take no part in local affairs, although it will maintain contacts through which information and activities of broad value will be secured and kept on file for the reference and assistance of all interested persons. It will study or promote the interchange of ideas and opinion, or supervise and sponsor research upon such matters affecting air clarification as:

a. Fuels, combustion, and fuel-burning equipment of all kinds.
b. Separation of sulphur and ash from stack gases.
c. Determination of methods for measuring density and quantity of foreign matter in gas streams.
d. Determination of methods for measuring air contamination.
e. Development of recommended, or endorsement of existing, standards of construction or procedure, wherever these should be prepared in the interest of the related or mutual benefits to manufacturer, purchaser or public.
f. Development of adequate and proper model smoke laws to meet community requirements.
g. To set forth and deal with such plans and suggestions, from time to time, as it deems proper and within its sphere, in order to keep pace with the general problem of air clarification in accordance with the increase of knowledge which will result from future developments. It is recognized that legislation and progress in the art of clarification must follow, and cannot precede, the technical knowledge necessary to their fulfillment.

4. In all of its work, it will be the purpose of the committee to be broadly informed in all essential viewpoints, so that its actions may be taken in full knowledge of their general effect. Opportunity to be heard will be provided for all important affected interests.

5. The bringing before it of all matters affecting pure air by organizations, companies, or individuals desiring a full and impartial consideration of their problems and an opportunity to learn the viewpoints of others, will be encouraged.

6. The work of the committee will be primarily to direct and coordinate present and future problems wherever arising, and wherever possible it will take advantage of existing committees, organizations and their machinery within its membership, to develop or solve any problems requiring sub-committee assignments.

7. The committee will not at any time assume autocratic powers, but will derive its strength, as a result of its position, as a professional body representative of the forces at interest. Its actions will be advisory and recommendatory rather than mandatory.

8. It will be the co-ordinator and clearing house for research projects within and relevant to its field. It will aid in the initiation of needed research and in advising investigators. It will receive and act as

Underwood and Underwood

Laying the 50 ft. sections of 14 in. pipe which will supply the Capitol at Washington with steam from the central plant. The illustration shows the derrick placing one of the pipes, which weighs 3500 lb., in place.

trustee and administrator of research funds in the interest of pure air.

The executive committee of the A.S.M.E. Pure Air Committee, which perfected the reorganization of the work carried on by the former sub-committee of the A.S.M.E. Fuels Division, is composed of the members of that sub-committee. They are Ely C. Hutchinson, editor, *Power,* New York, chairman; H. K. Kugel, acting smoke commissioner, City of Cleveland; H. B. Meller, Bureau of Smoke Regulation, Department of Public Health, Pittsburgh, Pa.; O. P. Hood, chief, technical branch, U. S. Bureau of Mines; Victor J. Azbe, consulting engineer, St. Louis, Mo.; Elliott H. Whitlock, research professor of mechanical engineering, Stevens Institute of Technology, Hoboken, N. J., secretary.

Charter representatives already accredited to the pure air committee are as follows: E. B. Ricketts, for the N.E.L.A.; Philip Drinker and H. S. Murphy, alternate, for the A.S.H.V.E.; H. B. Meller, for the Mellon Institute; and F. M. Van Deventer for the A.S.M.E. Fuels Division.

One of the first projects to be undertaken by the air committee will be action on the report of its sub-committee on setting heights for heating boilers, whose members are Elliott H. Whitlock, chairman, J. C. McCabe, chief boiler inspector, State of Michigan, Detroit, Mich., H. K. Kugel, and H. B. Meller.

Utilities Test Wind Rotors with Electric Generators

The first unit of an experimental plant to generate electric power by means of wind-operated rotors, modeled along the lines of the Flettner rotor, is being constructed at the plant of the Public Service Corporation of New Jersey, at West Burlington, N. J. The unit is being constructed by the United Engineers and Constructors, Inc., and the Baldwin Locomotive Works.

If the first rotor is successful, it is planned to construct a plant of fifteen to twenty rotor masts somewhere in the East. A full-sized plant will consist of about forty rotor units, with a capacity of 1000 kw. each.

Plans for the plant call for these rotor units to be mounted on wheels on a circular track, 3000 ft. in diameter. Each rotor will be 20 ft. in diameter and 90 ft. high. It will be made of duralumin and will revolve around a core of steel mounted on the track. A generator attached to a trolley, similar to that used in street cars, will supply the rotors with the initial impulse needed to revolve around the track. After that the rotors will revolve on the principle of the windmill, the wind supplying the necessary power.

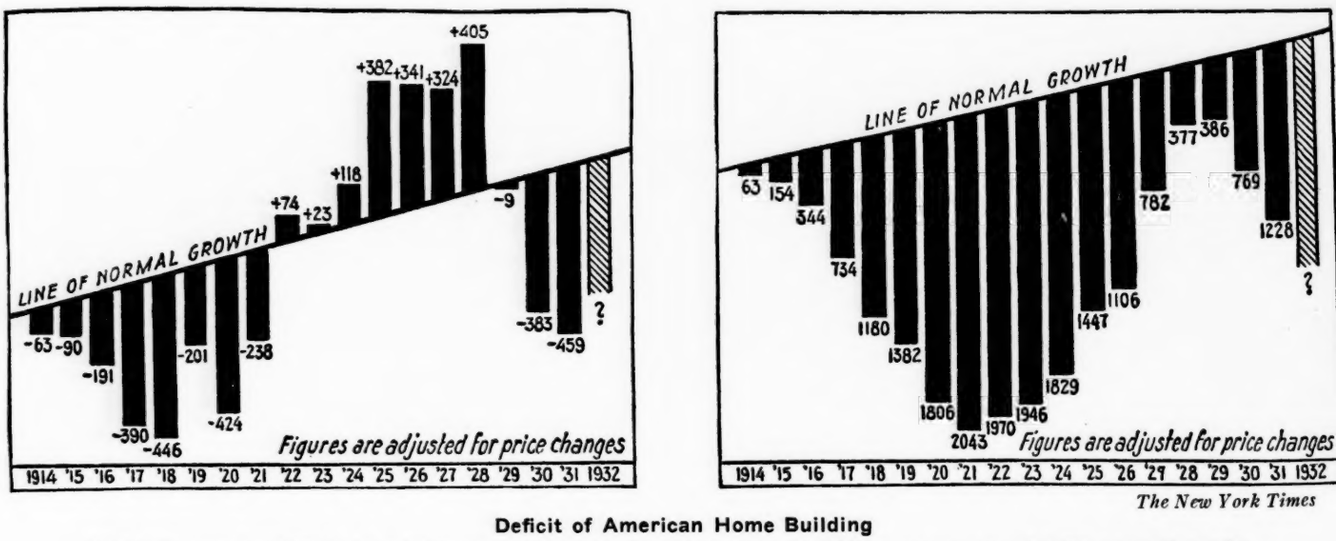
It was said that a wind of six miles an hour would be sufficient to operate the rotors.

Six of the larger utility companies in the East are financing the project. These include the Public Service Corporation of New Jersey, Detroit Edison Company, Middle West Utilities Company of Chicago, Standard Gas and Electric Company, United Gas Improvement Company and United Light and Power Company.

Hoover Conference Reports Expected to Aid Builders

Plans to make home building in the United States more practical and stimulate the erection of residences, the most complete information ever compiled on the types and costs of heating, plumbing and refrigeration equipment suitable for different climates, will be presented to the President's Conference on Home Building and Home Ownership when it meets in Washington December 2-5.

The information has been compiled by experts so that it can be made available to potential small homeowners. By making information of this type readily available to any person who wants it and by thus insuring a person that he can check on the installations to be made in his home, the conference hopes not only to stimulate an immediate interest in home building but to provide a permanent advancement in home construction.



The New York Times

Deficit of American Home Building

(Left) Excess or deficit, in millions of dollars, in American home building as compared with normal needs. (Right) The cumulative deficit, in millions of dollars, in home building compared with normal needs. In each chart the line shown is the line of normal growth in building requirements to meet the increase of population, and is based on the figures from 1900 to 1916.

Prof. Collins P. Bliss, Dean of the College of Engineering, New York University, is chairman of a committee on fundamental equipment that prepared the heating, plumbing and refrigeration reports.

To illustrate the extent of the information that has been gathered Professor Bliss recently cited the work of his subcommittee on heating, ventilating, and air conditioning. This subcommittee has divided the country into ten regions based on temperature ranges.

It has determined what types of equipment and systems for heating and ventilating are available, what the performance standards of these types are, keeping in mind that human comfort is the prime objective to be attained, and what the installation factors as affected by locality and house structure are.

In addition, the subcommittee has collected data on the fuels for domestic heating, and what their operating characteristics are; on the operation, care, and repair of equipment; on factors affecting health and comfort.

Three other subcommittees have dealt in somewhat similar fashion with plumbing and sanitation, with electric lighting and wiring, and with refrigeration.

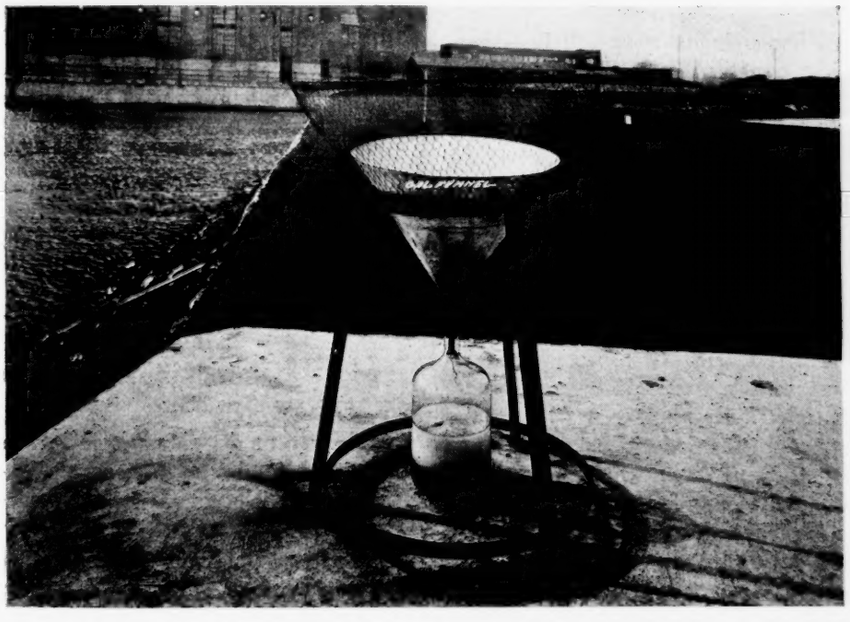
The reports of the 31 committees will cover all phases of home construction from the selection of the site to the final coat of paint.

A. E. Hanson, consulting engineer, New York, wrote the report on plumbing for the special committee working on this subject; A. C. Willard, Professor of Mechanical Engineering, University of Illinois, prepared the report on heating, ventilating and air conditioning, and Dr. Louise Stanley, chief of the Bureau of Home Economics, Department of Agriculture, is responsible for the report on refrigeration.

Fuel Oil Pipe Lines Planned

Plans for a pipe line system through which fuel oil would be distributed to consumers on the south shore of Long Island in the same manner that gas is now supplied to homes, were revealed recently when the South Shore Heating Company applied to the town board of Islip, L. I., for a permit to lay a pipe line system through the principal streets of Islip, Bay Shore and Sayville.

It has been planned to lay the pipe line next spring, and it probably would be a link in a pipe line system serving all towns along the Great South Bay, it was reported.



The deposit gauge used for collecting samples of impurities that have fallen from the air. A quantity of such particles is reported as total solids per unit of land area per unit of time. The gauge consists of a galvanized funnel 27 in. in diameter at the top, the inside surface being varnished to allow the particles to slide down into the 5 gal. bottle below partly filled with water. In the laboratory the contents of the bottle are measured to determine the amount of deposit, and analyzed to determine the percentage of water-insoluble particles.

The illustration is presented through the courtesy of the Detroit Edison Company, and is part of a paper "Measurement of Smoke Density and Soot Fall," read before the recent meeting of the Smoke Prevention Association, by W. A. Carter, technical engineer of power plants, Detroit Edison Company.

News of the Month

Smoke Abatement Commission Formed in Duluth

A smoke ordinance creating a department of smoke inspection and smoke abatement commission has been passed in Duluth, Minn.

Under the ordinance no heating or power plant except that on a locomotive or steamboat can emit dense smoke, defined under the Ringelmann chart as No. 3, or smoke that is too dense to be seen through when viewed directly over the top of the stack, for a period of two minutes or more during any 15 minutes in the day. An exception is made for the period when the boiler is being fired for the first time during the day.

All plans for new heating or power plants must be submitted to the commission for approval and it has power to compel alterations in existing plants that violate the ordinance consistently. Violations may be punished by a fine of not more than $100 or by a jail sentence of not more than 85 days.

Warm Air Heating Association Will Meet in Washington

The nineteenth annual meeting of the National Warm Air Heating Association will be held at the Mayflower Hotel, Washington, D.C., December 3-5, at the same time as the President's conference on home building and home ownership.

December 5 will be devoted to sight-seeing. The program follows:

December 3

8:30—Registration.

10:00—President's address, I. L. Jones.

10:30—"Air Conditioning in the Home," Frank B. Rowley, Director Experimental Engineering Laboratory, University of Minnesota.

11:15—"Our Coming Research in

Mechanical Warm-Air Heating," A. C. Willard, Professor of Mechanical Engineering, University of Illinois, Director of N.W.A.H.A. Research.

2:00—"Relation of the Bureau of Standards to the Problems of the Heating Industry," Hugh L. Dryden, chief of the aerodynamic division, U. S. Bureau of Standards.

3:00—Reports of officers and committees: code, research, trade relations, public information, and other committees and election of officers.

6:30—Banquet, informal. H. T. Richardson, toastmaster; guest speaker, Capt. Eugene P. H. Gempel, Chemical War Service, War Department, Washington.

December 4

10:00—"Merchandising Furnaces and Developing Repair Trade," W. H. Kratzer, Detroit.

10:45—"Good Air and Health," L. R. Thompson, Assistant Surgeon General, U. S. Public Health Service.

11:30—"Relation of Bureau of Mines to Warm-Air Heating," Onzi P. Hood, chief engineer, Mechanical Division, Technologic Branch, U. S. Bureau of Mines.

2:00—"Credit Granting," Dr. Stephen I. Miller, chief economist, R. G. Dun & Co., New York.

3:00—"Latest Developments from Our Research Work," A. P. Kratz, research professor, S. Konzo, special assistant, University of Illinois.

4:30—Adjournment.

Philadelphia Chapter See Steel Making Film

John L. Grimes, of the Wheeling Steel Corporation, presented a film entitled "Steel Making from Mine to Market," at the October 8 meeting of the Philadelphia Chapter of the A.S.H.V.E. The picture showed the making of steel sheets and pipe from the ore mines to the completed product.

The remainder of the meeting was devoted to the subject of "fans and their proper application to ventilating systems." Benjamin J. Adams gave a talk on the designs of different types of fans, their characteristics, and the applications of the different types to ventilating work. L. C. Davidson spoke briefly of fan characteristics and design.

F. D. Mensing spoke about the Research Laboratory. He explained the object of the laboratory and the many advantages and forward strides in the heating and ventilating industry that had been made possible by its work.

Second International Heating and Ventilating Exposition Supplement

All subscribers to HEATING AND VENTILATING will receive, without cost, a copy of the Second International Heating and Ventilating Supplement, which will be published in January, 1932. The Supplement will contain the programs of the meetings of the A.S.H.V.E. and A.S.R.E., a guide to the exhibits, and other valuable features of interest and value both to those who will attend the exposition and those who will be unable to be present.

Consulting Engineers Condemn Free Engineering

Through its council, the American Institute of Consulting Engineers has protested against the practice of manufacturers and jobbers in furnishing plans and specifications.

"The attention of the council of the American Institute of Consulting Engineers has been periodically called," the report said, "to the practice on the part of large manufacturers and distributors of equipment and materials of making investigations, engineering plans and specifications for architects and owners, involving the use of equipment and materials which they sell, all apparently without charge or for a nominal charge.

"It is clearly evident," the resolution says, "that the service is offered for the single purpose of selling their particular articles of manufacture, thus restricting the purchaser to products which may or may not be standard and of the best quality. It is equally evident that such practice is not only vicious, from the standpoint of the engineer engaged in private practice, but deprives the purchaser of the judgment of an impartial expert whose only interest is the interest of his client."

Corrosion Discussed by New York Engineers

The monthly meeting of the New York Chapter of the A.S.H.V.E., held November 16, was devoted to a paper on Corrosion in Heating Systems, prepared by R. E. Hall and A. R. Mumford.

Attendance taxed the capacity of the dining room of the Building Trades Employers Association. The length of the paper made it necessary for Mr. Mumford greatly to abbreviate it, but his presentation with the use of slides was most effective.

The discussion which followed was participated in by members of the cooperating bodies. Among the supplementary facts brought out was that the method of sampling the steam and the method of measurement used in analysis affected the properties shown. All agreed that the paper was most impressive and that it represented a thoroughgoing analysis of a difficult question.

Members of the power division, A.S.M.E., New York Chapter of American Institute of Architects, Heating and Piping Contractors New York City Association, and management division, Real Estate Board of New York, cooperated in the meeting.

W. H. Driscoll presided in his usual jovial manner.

Federal Buildings in Washington to be Air Conditioned

The recent decision of officials in charge of building government buildings in Washington, D. C., to equip the new federal office buildings now under construction or planned with air conditioning systems, will make Washington a leader in the air conditioning field. The Internal Revenue building, now occupied, and the major portion of the new Department of Commerce building will not be equipped with a cooling system because no provision was made for it in the plans. One wing of the Department of Commerce

building, which includes the secretary's office, will be so equipped, the plans having been changed while the building was under construction.

The government expects to equip six new buildings with air conditioning systems if Congress appropriates the necessary money, and it is believed that these appropriations will be forthcoming. These six buildings are the Department of Justice, the Post Office Department, Archives Building, Labor Department, Interstate Commerce Commission, and a building to house various independent bureaus and commissions. The air conditioning system is of vital necessity in the new Archives building. The installations in the other buildings, however, will be for the benefit of the employees.

Following the lead of the federal government, the District of Columbia commissioners have instructed Municipal Architect A. L. Harris to consider the feasibility of installing air conditioning systems in the four buildings which will constitute the new municipal center for the District of Columbia.

A. O. B. A. to Set Uniform Method of Determining Boiler Load

At the meeting of the board of directors of the American Oil Burner Association, held in Detroit, October 13, a recommendation was received from the technical research committee that the engineering departments of member companies cooperate with the committee to bring about a uniform method of determining boiler load.

An amendment was made to the model oil burner ordinance covering a paragraph relating to storage tanks.

Plans for the coming oil burner show were discussed in detail and regulations adopted in connection with the operation of burners at the show.

1931 Annual Index

The annual index for the twelve issues of HEATING AND VENTILATING for 1931 has been prepared and will be mailed on request to any subscriber without cost. Address Subscription Department, HEATING AND VENTILATING, 148 Lafayette St., New York, N. Y.

Oil Burners for Warm-Air Furnaces to be Feature of Exposition

Oil burners, designed especially for use in warm-air furnaces, will be a prominent feature of the Second International Heating and Ventilating Exposition, in Cleveland, January 25-29, 1932.

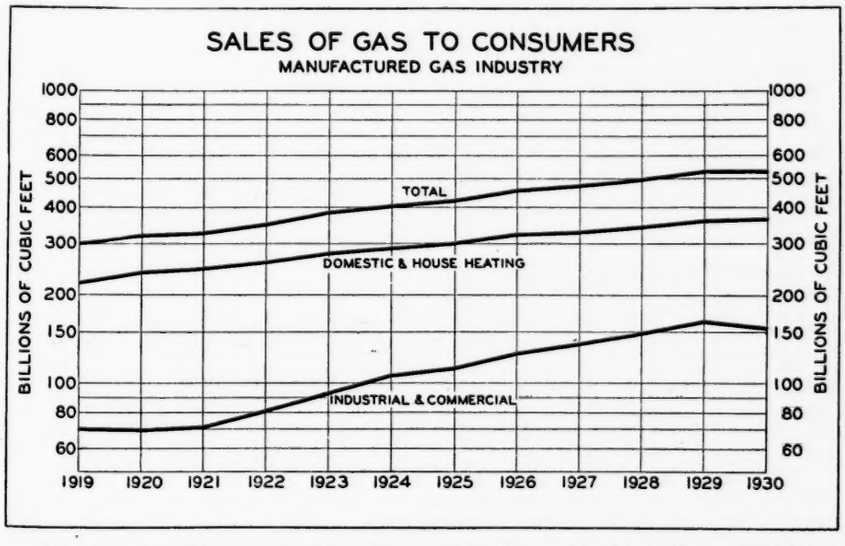
It is reported that one exhibitor will show a circulating unit for hot water heating systems involving a fundamentally new conception of radiator heating. In the new method hot water is used as the carrier of the heat units, the movement of that carrier being entirely independent of its temperature. By this method, it is claimed, it is possible to secure a greater heat transfer efficiency from the flue gas to the water and thence to the radiator surface.

Another display will be in the form of a glass model of a steam trap operating under 5 lb. steam pressure whereby the cycle of operation and advantages of this type of construction may clearly be seen.

An oil burner manufacturer is arranging to display two complete installations, one in a square boiler and the other in a round boiler.

In this particular display not only will the burner unit be of a new design, but it will include a new design of control stand, a new remote control switch, a new movable electrode for electric ignition, new nitralloy bearings and a new hearth.

Notable advances will be seen in the design of radiator covers. Among the new designs are all-steel, all-welded covers, with tops treated with marble, inlaid effects, glass and porcelain.



An almost constant percentage increase is shown for domestic and heating uses of gas on this logarithmic curve from an American Gas Association report.

Carrier Honored by A.S.M.E.

Willis H. Carrier, president of the Carrier Corporation and of the A.S.H.V.E., nationally known air conditioning authority and manufacturer, will be presented with a John Scott Medal by the American Society of Mechanical Engineers at the fifty-second annual meeting of the society, November 30-December 4. The presentation will be made President's night, December 1.

District Heating Subject of Pittsburgh Meeting

At the regular monthly meeting of the Pittsburgh Chapter of the American Society of Heating and Ventilating Engineers, held November 9, Dwight L. McNulty, mechanical engineer, Byllesby Engineering and Management Corporation, spoke on design and construction of underground steam lines with particular reference to some problems encountered in Pittsburgh.

Nominations for officers for the

coming year were reported by W. W. Stevenson, chairman of the nominating committee, as follows: R. B. Stanger, president; F. C. McIntosh, vice-president; J. L. Blackshaw, secretary; H. B. Orr, treasurer. For board of governors, F. C. Houghten, G. S. McEllroy and H. Lee Moore.

President Houghten appointed F. C. McIntosh to represent the chapter on the national nominating committee, with T. M. Dugan as alternate.

Dr. Samuel Wesley Stratton

Dr. Samuel Wesley Stratton, chairman of the corporation of the Massachusetts Institute of Technology, Boston, and president of the institute from 1923 to 1930, died unexpectedly October 18 at his home in Back Bay. Death was caused by a form of constriction of blood vessels.

Doctor Stratton had appeared in the best of health despite his 70 years. He returned recently from a month's trip to England where he attended the Faraday celebration.

Doctor Stratton, as Director of the Bureau of Standards, acted as chairman of a meeting held March 7, 1914, in Washington, D. C., to standardize flanges and flanged fittings. A subsequent meeting was held in New York, March 20, 1914, with representatives of the National Association of Master Steam and Hot Water Fitters, the American Society of Mechanical Engineers, and the manufacturers of valves and fittings present.

Doctor Stratton was born in Litchfield, Ill., and graduated from the University of Illinois in 1884, later becoming professor of physics and electrical engineering at the school. From 1892 to 1901 he was a member of the faculty of the University of Chicago and for the next twenty-one years he was Director of the Bureau of Standards at Washington, D. C. Largely responsible for the organization of the bureau, he built it from a small office employing two or three persons into a unit of the Government which occupies several buildings and is manned by a staff of nearly 1000 employees.

When he resigned as Director of the Bureau of Standards, to accept the presidency of the Massachusetts Institute of Technology at Boston, President Hoover, then Secretary of Commerce, paid public tribute to him.

Alfred J. Henry

Prof. Alfred J. Henry, editor of the *Monthly Weather Review,* died October 5, after more than 50 years of service with the United States Weather Bureau. Professor Henry was born September 1, 1858, and was educated in the public schools of New Bethlehem, Pa., and in Columbia University, now George Washington University, in Washington. In 1885 he became chief of the meteorological records division of the Weather Bureau.

Professor Henry was a former secretary of the National Geographic Society, a fellow of the American Meteorological Society, and of the American Association for the Advancement of Science, and a member of the Washington Academy of Science, the Philosophical Society of Washington, and the American Association of Geographers. He was author of "Rainfall of the United States," "Wind Velocity and Fluctuations of Water Level on Lake Erie," "Climatology of the United States" and "Weather Forecasting in the United States."

COMING EVENTS

DECEMBER 3-5, 1931. Convention of the National Warm Air Heating Association, Washington, D. C. Headquarters at the Mayflower Hotel.

JANUARY 25-28, 1932. Joint-Annual Meeting of the American Society of Heating and Ventilating Engineers, and the American Society of Refrigerating Engineers, at Cleveland.

JANUARY 25-28, 1932. Second International Heating and Ventilating Exposition, at Cleveland, Ohio.

JANUARY 25-30, 1932. National Association of Sheet Metal Contractors, Louisville, Ky. E. M. Pope, Chairman, Publicity Committee, 58 W. Washington St., Chicago.

APRIL 11-16, 1932. Ninth Annual Convention and Oil Burner Show of the American Oil Burner Association, Mechanics Building, Boston, Mass.

JUNE 14-27, 1932. Annual Convention of the National District Heating Association, to be held in Pittsburgh, Pa. Headquarters at the William Penn Hotel.

JUNE 20-23, 1932. Fiftieth Annual Convention and Exhibit of the National Association of Master Plumbers, at Madison Square Garden, New York.

JUNE 26-30, 1932. Semi-annual Meeting of the American Society of Heating and Ventilating Engineers, to be held in Milwaukee, Wis.

Richard T. Crane, Jr.

Richard T. Crane, Jr., president of Crane Co., Chicago, Ill., died November 7 in the Doctors' Hospital, New York, from heart disease. His death occurred on his fifty-eighth birthday.

Mr. Crane's entire business career was spent in the plumbing and heating manufacturing and wholesale business, which was founded in 1855 by his father, the late Richard T. Crane. A year after his graduation from Yale University, Mr. Crane entered Crane Company, becoming second vice-president in 1898 and president in 1914.

Edgar R. Hawley

Edgar R. Hawley, president of the Hawley-Richardson-Williams Co., Salt Lake City, Utah, and a prominent consulting heating and ventilating engineer in the West, died recently of acute pneumonia. He was born October 12, 1887, in South Bend, Ind.

As consulting engineer for many of the leading architects in the West, he designed the heating and ventilating systems for a number of large buildings, including the state capitols of both Utah and Idaho.

Arthur P. Mager

Arthur P. Mager, manager of the heating department of The National Supply Co., Toledo, Ohio, died on October 27, 1931.

Mr. Mager, who was born in Toledo on September 6, 1886, started as an office boy in the company on June 1, 1903.

Correspondence

Air Conditioning and the Consulting Engineer

EDITOR, HEATING AND VENTILATING:

I note in the November issue of HEATING AND VENTILATING an article by M. G. Harbula entitled "Vital Questions in Air Conditioning," and also your editorial in the same issue entitled "Air Conditioning and the Independent Engineer."

I realize in this discussion that arguments may be presented on both sides of the questions raised, but I think that where both the author of the paper in question and the editor in his editorial comments have completely missed the point is in confusing the function of general consulting engineers with those of specialists or design engineers.

Is it not the function of the consulting engineer to select and coordinate equipment, for the most part standard manufacturers' equipment designed and completed by them, to perform certain definite functions? The consulting engineer cannot, in the very nature of things, be expected to design all of the various types of equipment that he specifies. In the fan, for example, the bracing of the fans, weight of sheets used, the size of the shaft, the construction of the rotor, are all matters of manufacturers' design. It is true the consulting engineer could, if he wished, design a complete fan, but in practice he does not, and that is not what he is employed for. The same is true of refrigerating machines and motors. Of course, the consulting engineer is at liberty to, and may, as he frequently does, favor one type of apparatus construction, just as he may favor one elevator, or one fan, or one motor, over another make either directly or indirectly through the restrictions of his specifications. This privilege, if properly used, may be desirable, as it sets up certain definite standards, but the consulting engineer in making these specifications is not himself the designer of the equipment. He is simply specifying what the manufacturer has already determined as good practice. In other words, he is copying certain of the manufacturer's specifications and this may be, and probably is, often in the interest of the purchaser.

The primary purpose of the consulting engineer, however, is to act for the purchaser in selecting the type of standard equipment that will in his estimation be the most serviceable, and to correlate it to other equipment, adapting it to requirements of the purchaser.

The designing engineer, on the other hand, must be a specialist if he is to compete with the specialist designers of the manufacturer. He is perfectly free to do this if he chooses, but in doing so he should not object to the competition of the manufacturer who has his own patented design to present.

What Mr. Harbula is really discussing, and your editorial also discusses, is not competition with the consulting engineer, but competition between the specialist or designing engineer and the manufacturer. The latter must, of necessity, be in the field of designing engineering if his product is to have any merit, or if it is to give its greatest use to the owner in its application. The real criterion of merit in either case seems to be the question of what will best serve the owner's interest.

Mr. Harbula very properly brings up the question of safeguarding the owner's interest. This is certainly the function of the consulting engineer, but in doing so he must generally adapt standard manufacturers' equipment, of which complete specifications are available, and which are designed in detail and with care and responsibility by the manufacturer or manufacturers.

Who designs the steel work of our skyscrapers or of our large bridges? Not the consulting engineer, but the specialist in structural steel design. It is true he may be employed by the consulting engineer and, in rare cases, this specialist designing engineer may also act as consulting engineer. It is common knowledge, however, that most of the real detail work of designing is placed in the hands of a steel company, or a bridge company, which are in a position to render expert service, and which cooperate with the consulting engineer in best fulfilling the owner's requirements.

It is a very useful and necessary function of the consulting engineer, just as Mr. Harbula points out, to see that the manufacturer, who of necessity must be a designing engineer, does not "put one over" on the owner, and to act as an advisor both of the owner and of the manufacturer or contractor as to what general requirements should be met, and as to whether the proposals of the designing engineer do in fact meet these requirements.

The air conditioning system, which Mr. Harbula quotes, is only one part of the contract although a vital one. Without such specifications and guarantee of performance the owner must take all of the responsibility for the consulting engineer's design meeting the requirements. It is only for the owner's protection, as well as that of the consulting engineer, that such performance specifications and guarantees seem desirable. If this were the only specification of the contract, it would be quite true, as Mr. Harbula points out, that the owner would not be fully protected because of the possible substitution of cheap equipment and materials, and probably of high cost of operation and maintenance. Personally, I know of no contract or proposition submitted on such a basis. In every case that has come to my knowledge, standard equipment of known design and characteristics has been specified. The owner has further been protected, or if not it has been the function of the consulting engineer to see that he was so protected, in the specification of the power required for every element of the equipment.

Mr. Harbula also points out the fact that temperature and humidity guarantees alone are insufficient, and that absence of drafts and noise is important. This is correct.

Noise, or sound, is capable of definite measurement and can be expressed in definite units—decibels.

Correspondence

Likewise, drafts can be determined with accuracy by means of the kata-thermometer. There are definite known standards of sound limitation for ventilating systems depending upon their location. For sound studios, for example, the noise level of the ventilating apparatus in the room should be below 7 decibels; for general offices, they should be below 30 decibels, and for private offices below 20 decibels. These are just as definite specifications capable of definite measurement as temperature and humidity, and it is the function of the consulting engineer to see that they are properly included in the specifications. Reasonable manufacturers for their own interest generally see to this, regardless of whether it is specified or not, because otherwise their apparatus will not be acceptable.

Air movement, turbulent or otherwise, should probably be below 50 ft. per min. as registered by the kata-thermometer. This is also capable of definite measurement, and the consulting engineer can very well insist that such requirements of air movement be incorporated in the contract to protect the owner.

As to the design and construction of the duct work, an essential part of the system, drawings are almost invariably submitted with the proposal, and the specification gives the gauges and type of construction to be employed and the make of material to be used. This is frequently modified by special items of the consulting engineer regarding these several features. Specifications usually are, or at least should be, sufficiently explicit to avoid any shoddy workmanship or cheapening of equipment. It is the business of the consulting engineer to see that such specifications are complete in this respect and to protect the owner's interest.

As to the quantities of air involved and the method of distribution, both of which are tied up together, as Mr. Harbula well outlines, this must, of necessity, be the function of the designing engineer and the manufacturer and constructor of the system because, if he is to be held responsible for the results to be accomplished, he can only assume that responsibility with the provision that the air quantities and the distribution are such that it will fulfill the contract. It is the function of the consulting engineer, however, to pass judgment upon the capability of the contractor to assume such responsibility. The responsibility for results must be assumed in the end either by the contractor, or by the owner through his engineer, and the preference of the owner must determine this decision.

The manufacturer, whether it is of a large turbo generator set, an elevator installation, or a complete air conditioning system, must necessarily design the details of his equipment and accept the responsibility if he is to succeed, and if he is to perform a real service to the purchasing public.

Ninety-nine per cent of all the improvements that have been inaugurated in fields such as these have come about as the result of research effort and design studies of the manufacturer. All the developments up to the present time, such as the design of humidifiers, and the various accepted methods of distribution of air—as in theaters, for example—have come about entirely through the research efforts of the manufacturer, as they properly should. The manufacturer today to keep abreast of the art in which he is engaged must, of necessity, spend large sums in research with the purpose of not only improving his equipment but in improving its method of application. There would be very little advance in any art if this was not done, and it is only the larger organizations that can afford to do this properly. Should they not get some return for this, at least the return of the actual cost of this research endeavor? The public, and I believe generally the consulting engineers, recognize the justice of this. The writer has proposed that research work be carried on at the A.S.H.V.E. research laboratory on methods of air distribution in order that quantitative formula may be evolved for the general use of engineers and manufacturers. This is one of the topics to be covered by the research laboratory. Where such public research work is done it is naturally the property of everyone, but where it must be done, and can in many cases only be done, by the manufacturer, it certainly is the manufacturer's property to do with as he sees fit.

I believe that there are something less than five hundred consulting engineers in the entire country who have anything to do at any time with ventilation projects. It could hardly be expected that they could, or would be willing to, support alone the cost of expensive investigations as suggested by your editorial, but through the research laboratory of the A.S.H.V.E. I believe much could be done along this line, and I believe it is highly desirable if the society members as a whole express their wish to spend their money in this way.

In general, I personally can see no justification for the assumptions in the editorial that the large corporate interests, manufacturer or otherwise, will ever take the place of the independent practicing consulting engineer. There never will be only one elevator company, only one electric company, only one heating company, and I hope there will never be one air conditioning company.

It is competition that spurs on improvement in industry and brings costs to the consumer down to the minimum, providing always such competition is not excessive and destructive. Equipment must be chosen by the owner, and as long as there is competition the tendency to substitute or to give less valuable service on the part of the manufacturer, owing to the exigencies of such competition, can only be avoided by the owner or the consulting engineer in seeing to it that his requirements are met by the equipment offered. In competition especially, it is vital that the consulting engineer be the arbitrator and final dictator in representing the owner's interest, and this function is of service not only to the owner but to the better manufacturer as well, as it permits them to design and build to an objective of quality rather than to price alone.

W. H. Carrier

Newark, N. J.

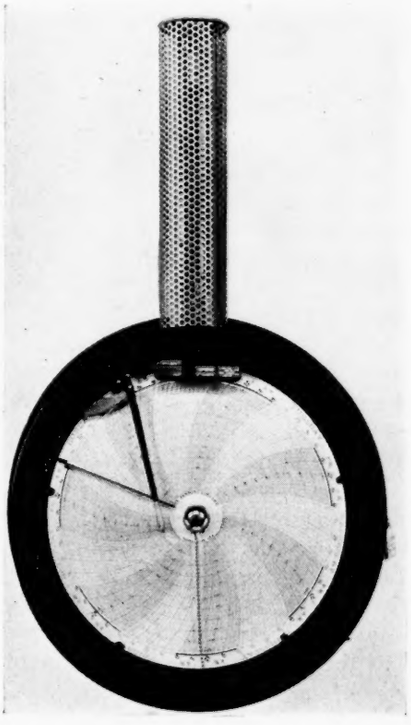
New Equipment

Foxboro Relative Humidity Recorder

The new relative humidity recorder, manufactured by the Foxboro Co., Foxboro, Mass., is entirely self-contained. It employs no water boxes, blowers or other auxiliary apparatus and can, therefore, be moved from place to place as required. It does not operate on the wet and dry bulb principle, but gives readings direct in relative humidity, regardless of ambient temperature.

The operation of the recorder depends on the use of a special membrane which is mounted on the top of the case and is connected directly to the pen arm. The membrane is based on the principle that the moisture regain or equilibrium moisture content be calibrated directly in terms of relative humidity. In other words, the gain or loss in tension caused by the changing of the moisture content of the membrane changes the position of the pen and records the atmospheric relative humidity directly on a chart. The chart is rotated by a clock so that the record shows not only the relative humidity but also the time of each change. The chart is printed under controlled humidity conditions on a special Humitex paper which is much less affected by moisture than the ordinary paper used in the making of charts.

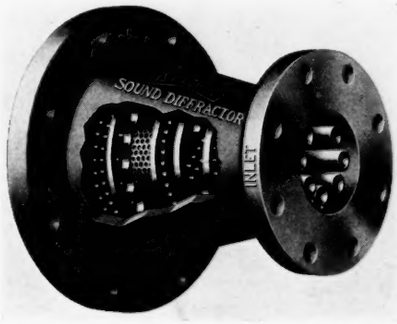
At temperatures between 26° F. and 120° F., the recorder offers an accurate method of recording humidity. Its accuracy is plus or minus one degree. The recorder can also be furnished combined with a thermometer so that both the temperature and humidity are recorded on the same chart.



Relative humidity recorder

Boylston Sound Diffractor

A sound diffractor for preventing the creation of noise caused by steam after it passes through a reducing valve has been placed on the market by the Boylston Steam Specialty Co., 122 West Illinois St., Chicago, Ill.



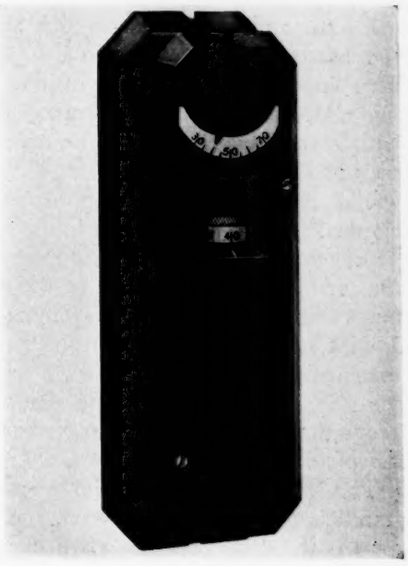
Device for preventing noise in piping

The device contains diffractor discs spaced in the casing so as to repel the propagation of the sound vibrations which, in many cases if no such device is used, are transmitted throughout the entire building.

The device is made with flanged ends only which can be supplied either drilled to the 125 lb. American standard template for standard drilling or with flanges blank. The device is available with inlet sizes ranging from 1 in. to 12 in. and outlet sizes from 3 in. to 24 in.

Barcol Hygrostats

A hygrostat, designed to meet the demand for an inexpensive instrument for controlling humidifying apparatus by electrical means, has recently been added to the electric system of temperature control of Barber-Colman Co., Rockford, Ill. The instrument is essentially an automatic two-way switch operated by changes in the length of a wood cylinder as it reacts to changes in atmospheric moisture content. The hygrostat not only actuates controlled mechanisms on a variation of less than 4% in relative humidity, but indicates the existing humidity by means of a pointer and scale mounted in the instrument.



Humidity control

The device is mounted on an insulating base of phenolic resin, and protected by a moulded cover of the same material. All metal parts are carefully rust-proofed to insure maximum life and continued dependable service.

Adsco Insulation Support

To correct pipe insulation disalignment and distortion and increase transmission efficiency, the American District Steam Co., North Tonawanda, N. Y., has designed an insulation support which permanently holds the pipe covering concentric with the pipe. In conventional methods, the insulation hangs on the pipe. Weight of the insulation plus the weight of accumulated

moisture gradually causes the covering to sag away from the pipe at the bottom and pull thin on top. This condition reduces the insulating effectiveness of the covering—with increasing heat losses as time goes on.

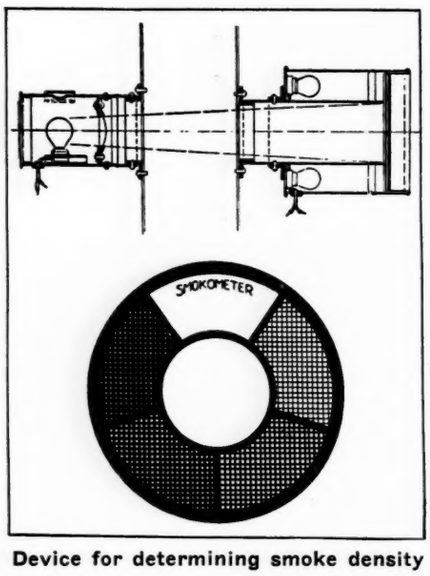
The Adsco insulation support is claimed to eliminate these disadvantages. With the new support, the pipe covering is cradled in wide brass bands. Each band is hung from a saddle which passes through the insulation and rests directly on the upper surface of the pipe. This keeps the insulation concentric with the pipe.

The supports are available in standard pipe sizes up to 24 in., and for 1½ in., 2 in. and 3 in. covering.

Smoke Indicator

The Smokometer, a simple form of smoke indicator, has been placed on the market by The Sales Corp., 1708 Lewis St., Richmond, Va. It is designed so that it may be used as a direct reading instrument mounted on uptake or flue, an indirect reading when mirrors are used to reflect images of the instrument to any desired point, or as a remote reading indicator when the instrument is mounted on control board and samples of the flue gases passed through it.

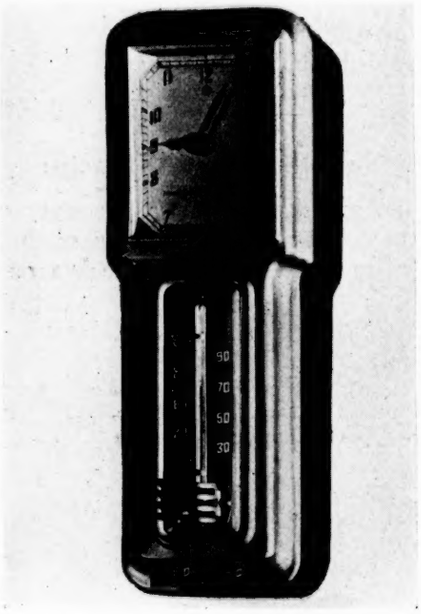
The device consists of a projector throwing a beam of light across a smoke passage to an indicator, as shown in the cross section. The rays fall on the center portion of the instrument face shown in the lower illustration. Smoke particles cut out the light and form shadows, varying with the density of the smoke, on the central portion of the screen. Around this central shadow screen are arranged standard illuminated sectors corresponding to the Ringelmann smoke density scale.



Device for determining smoke density

Minneapolis-Honeywell Electric Clock Thermostat

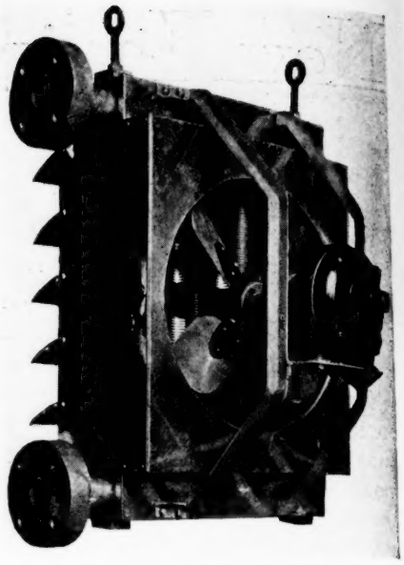
A new line of electric clock thermostats has been placed on the market by the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. The clock is operated from the house lighting circuit and requires no attention. In case of current failure the clock restarts itself. The adjustable range of the thermostat is from 55° to 85°, with a 2° differential. The thermostats are available with week-end shut-off, holiday shut-off or night switch at extra cost.



Electric clock thermostat

Niagara All-Aluminum Unit Heater

The Niagara Blower Co., 6 East 45th St., New York, has announced a solid welded all-aluminum disc-fan unit heater.



All-aluminum unit heater

Tubes are vertical and designed for 150 lb. working pressure. The units are available in ten sizes with capacities ranging from 30,400 B.t.u. per hr. to 132,000 B.t.u. per hr. at 2 lb. steam pressure and 60° entering air temperature.

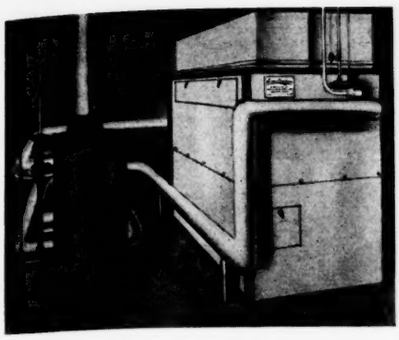
The company is also manufacturing a line of heaters similar to the ones just described except that the heating surface is of copper with the tubes slightly sloping from the horizontal.

Capacities of these units range from 37,300 B.t.u. to 163,800 B.t.u. per hr. at 2 lb. steam pressure and 60° entering air temperature.

Sirocco Conditioner

American Blower Co., Detroit, Mich., has announced the Sirocco conditioner, designed for heating, humidifying, cooling and filtering the air in residences and other small buildings, such as small stores, offices and churches.

As a heating system, hot water is supplied to the heating surface from a separate boiler. A thermostatically controlled fan blows the air over the heating surface and forces it to the various rooms, into which the air enters through grilles. As a cooling system, tap water is supplied to the surface, resulting in cooling the temperature of the air depending on the temperature of the water and the available quantity of water which can be used. The air does not come into direct contact with the cooling water.



Residence air conditioner

During the heating season a spray type humidifier adds moisture to the air. Dry filters, of the cloth bag type, remove the dust and dirt from the air.

The unit is supplied in a gray enameled steel casing, and includes the heat transfer surface, fan, filter, and humidifier, but not the boiler.

Series 1R Tube-Turns

A lower priced line of fabricated fittings for welding piping, Series 1R, has been announced by Tube-Turns, Inc., Louisville, Ky. The new line is of seamless tubing, with uniform wall thickness, and the fittings have the same outside diameter, inside diameter, wall thickness and wall tolerance as the pipe with which they are used.

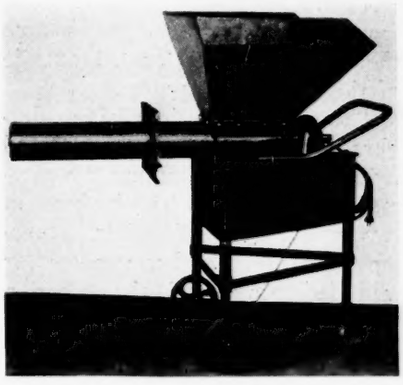
The addition of the new series rounds out and completes the company's line, according to the announcement, affording 45° and 90° elbows and 180° return type fittings for welding in sizes ¾ in. through 20 in. and in virtually all the weights required by modern piping.

Type EB Oriflo Meter

Builders Iron Foundry, Providence, R. I., has placed on the market its Type EB electrically operated Oriflo meter for measuring fluid flow. It can be used in connection with the flow of steam, water, oil or gas.

The complete meter consists of the differential producer, which can be an Oriflo plate, a venturi tube or a venturi nozzle; a mercury unit by means of which the inductance in one coil is increased and in the other decreased, producing a change in voltage across the coils; a recording device, in which the change in voltage across the coils results in movement of an indicator.

Advantages claimed for the meter are: highly sensitive and responds rapidly to changes in rate; remote installation of instruments possible; hinged mounting exposes interior of instrument without disturbing normal operation; hexagonal case with small, accurately spaced chart presents neat appearance and conserves panel space; meter capacity changed merely by replacing one mercury well cover; easily read straight reading counter driven by simple and direct integrating mechanism; frictionless mercury unit contains only one moving part, the float; electrical circuit completely isolated from the mercury as well as from the fluid metered, and no error from voltage variations.



Portable stoker

Crosley Autostok

The Crosley Radio Corp., Cincinnati, Ohio, is introducing a moderately priced stoker for boilers and furnaces having an inside diameter of 12½ in. to 34 in. to burn soft coal, anthracite or coke.

The hopper will accommodate 200 lb. of hard coal or 140 lb. of coke. There are three speeds, the maximum coal feeding rate being 40 lb. per hr.

The capacity of the unit is 850 sq. ft. of steam radiation. It is driven by a 1/6 hp. motor and has an automatic safety control switch in case the conveyor is clogged, thus doing away with the necessity for a shearing pin.

A cooling cylinder is placed around the feed pipe, eliminating the caking of fuel and hopper smoke.

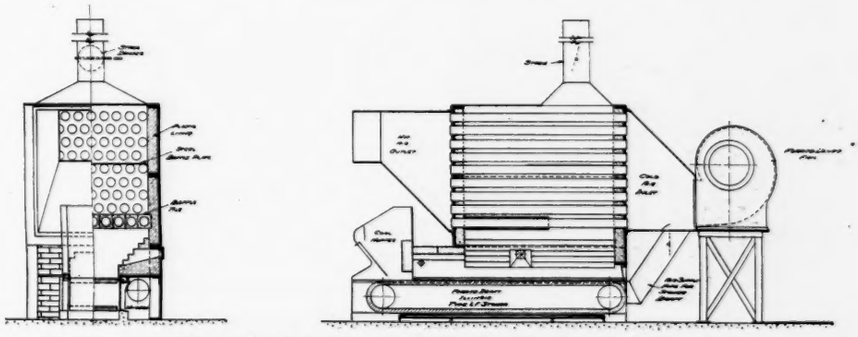
The unit is supplied complete with control panel, thermostat, and the necessary connections.

It is finished in red and black enamel and is readily portable so that the hopper can be wheeled to the coal bin for filling.

Stoker-Fired Warm-Air Unit for Shops

The Illinois Stoker Co., Alton, Ill., has announced a shop heating unit which is a combination of a small chain grate stoker and a warm-air forced draft heating unit. The company's 50—250 hp. small chain grate stoker is used in the unit in connection with a newly developed warm-air unit through which air is blown by a standard type 5000 c.f.m. blower.

The simplicity and heating range of the unit make it desirable for heating repair shops and other large open structures. It is 5 ft. wide by 16 ft. long by 8 ft. high. Since the entire heating installation is combined into one unit, a considerable saving in overall space requirements is made. No piping or other installation work is necessary other than



Stoker-fired warm-air heater for industrial jobs

providing a foundation for the unit, a stack connection and outlet connections to warm-air ducts, if distribution requires a division of the outlet stream of warm air into two or more ducts.

G. E. Electric Air Heaters

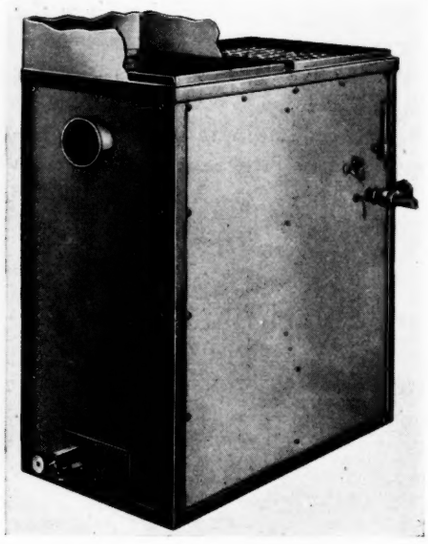
A line of horizontal electric air heaters for industrial applications is announced by the General Electric Company. Five ratings are listed: 1,000 watts at 115 volts; and 1,000, 2,000, 3,000 and 4,500 watts at 230 volts.

The heaters consist of a number of G. E. strip heaters mounted in black japanned, perforated, pressed steel cases. Each is equipped with 3 ft. of armored cable and a three-heat snap switch mounted on a standard conduit box. They are designed for wall or floor mounting.

Surface Combustion Forced Air Furnace

The Surface Combustion Corp., Toledo, Ohio, has introduced a gas-fired warm-air furnace.

The unit is 49 in. high and occupies a small space. A multi-blade type blower is used together with a dry type air filter. The furnace is made in one size.



Gas-fired warm-air furnace

Foran Copper Tube Boiler

Foran Boiler Co., Inc., Flemington, N. J., has announced a line of copper and steel tube boilers, designed for burning coal, gas or oil. Three-quarter inch copper tubes are nested together so as to form a large amount of heating surface.

The boilers are available in seven sizes, capacities ranging from 500 sq. ft. to 2400 sq. ft. of steam radiation, maximum.

Powers Thermostatic Radiator Valve

The Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill., has announced the Powers thermostatic radiator valve designed to control the temperature of rooms heated by vapor or vacuum heating systems.

The company claims that the control is not influenced by radiant heat from the radiator as the remote thermostat can be located outside of the radiant heat zone.

The device consists of a diaphragm-operated valve connected by armored flexible tubing to a thermostat which can be obtained in two styles: one enclosed in a thermostat case with thermometer for wall mounting, and the other a tubular shaped thermostat of the bulb type for use with concealed radiation, unit heaters, and wall type radiators.

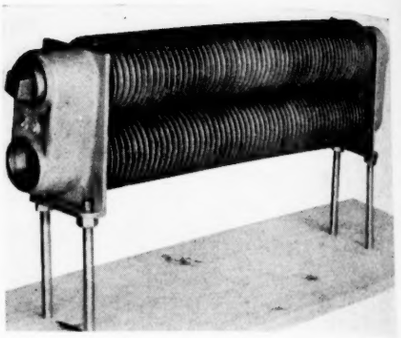
It is claimed that the accurate temperature control secured with this regulator is due to the larger sensitive surface of the thermostat, which is influenced by the room temperature, and to the greater area of diaphragm bellows used to open and close the valve.

Grid Concealed Convectors

The Unit Heater and Cooler Co., Wausau, Wis., has announced a grid concealed convector line available in either cast iron or cast aluminum sections.

The convectors are composed of one or more varying lengths of 3 in. diameter round sections with extended surface. The assembled unit is equipped with adjustable legs complete for piping connections.

The company is prepared to furnish sheet metal enclosures, grilles and cabinets.



Convector heating element

Lengths are available from 15 in. to 75 in. and are designed to serve applications for 4 in., 6 in., and 10 in. walls.

Stainless Steel Expansion Joints

The Thomas R. Heyward Co., Pittsburgh, Pa., has developed a line of expansion joints constructed with diaphragm type bellows of duraloy stainless steel.

The gasket joint fits between standard flanges and takes care of the expansion in one joint of steam piping. The joint maintains its sealing pressure from flat springs in the bellows, and the gasket surface is of asbestos cloth, impregnated with graphite. When used in Van Stone couplings, they form a swing joint which has as much movement as may be desired.

These swing joints are made up by using stop or clamping rings around the flanges, allowing full tightening of the coupling bolts and causing the swing action of the inner flanges to be properly supported and guided. These joints have a constant spring pressure, and necessary slippage is performed by the polished bellows surface between the lubricated asbestos gaskets.

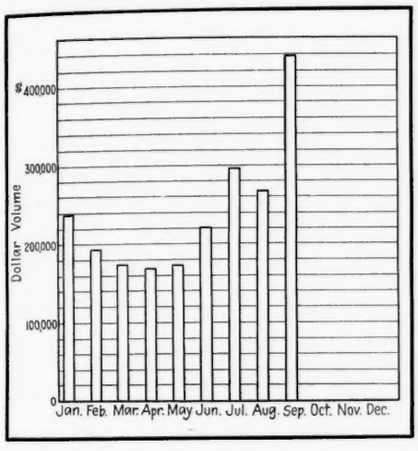
The multiple bellows is of the same diaphragm construction as the gaskets, and all joints of the relatively thin metal are welded in automatic fusion welding machines. Reinforcing is accomplished by means of external strips of resilient metal. These joints require no special dies and their construction is relatively inexpensive. All flanges are of forged steel, properly attached to the bellows, and the outer sleeve-cover forms the limit stops for correct installation. They are built for any steam temperature or pressure.

Statistical Service

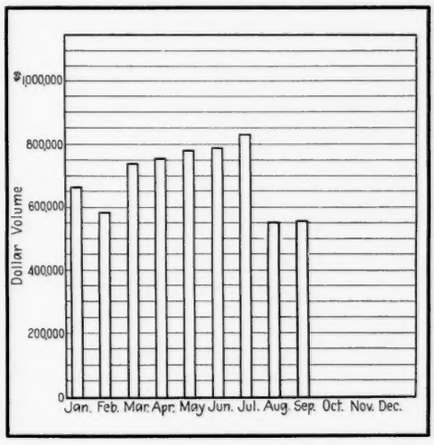
THE usual seasonal increase is reflected in many of the items reported below for September. Industrial unit heater orders appear the most optimistic, inasmuch as they show an increase of 56.9% over the preceding month. A greater increase in percentage, 68%, is shown in the reports of indirect heating surface, but in actual dollars the increase is only about one-third as great as that of industrial unit heater orders. Stoker installations continue to climb this month, and show the rather surprising total of 1431.

In connection with stokers it is important to note that the stokers reported in this department do not include power stokers, or the very large commercial stokers. They do include the residential, apartment house, small commercial heating jobs, general commercial heating, and the small high-pressure steam plants.

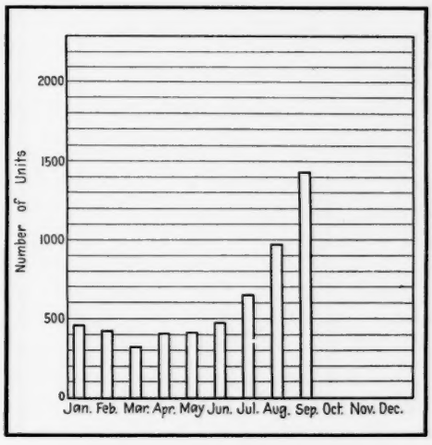
Figures for boilers, oil burners and radiators show a decrease over the preceding month. Cast iron radiators show the smallest reduction in percentage, 16.4%, for the month of September, as compared with the same month in 1930.



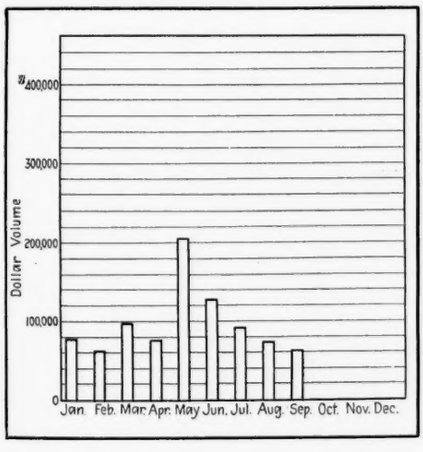
Unit Heaters (Industrial)
Orders in Dollars
September, 1931, $419,410; August, 1931, $267,361; increase, 56.9%.
(Data not reported prior to January, 1931).



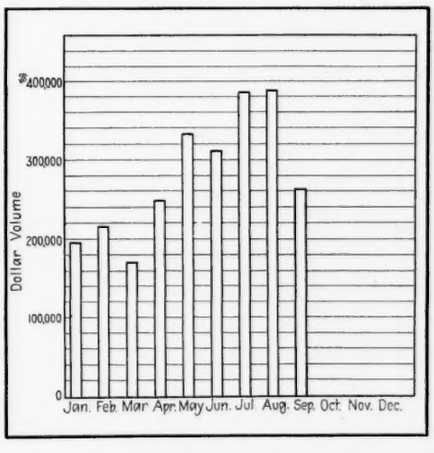
Fans and Blowers
Orders in Dollars
September, 1931, $562,272; August, 1931, $553,544; increase, 1.6%.
(Data not reported prior to January, 1931).



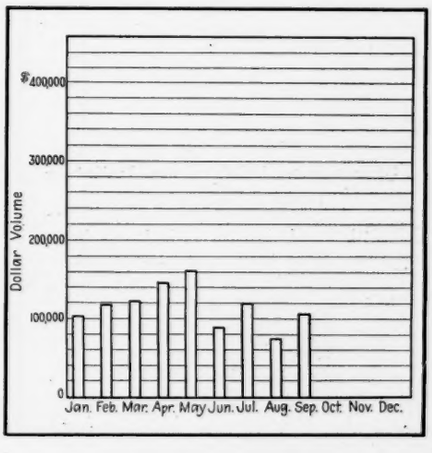
Mechanical Heating Stokers
In Number of units installed
September, 1931, 1431; August, 1931, 977; increase, 46.5%.
(Data not reported prior to January, 1931).



Air Washers and Air Conditioning Units
Orders in Dollars
September, 1931, $60,955; August, 1931, $74,615; decrease, 18.3%.
(Data not reported prior to January, 1931).



Unit Heaters (Schoolroom Type)
Orders in Dollars
September, 1931, $262,274; August, 1931, $388,317; decrease, 32.4%.
(Data not reported prior to January, 1931).

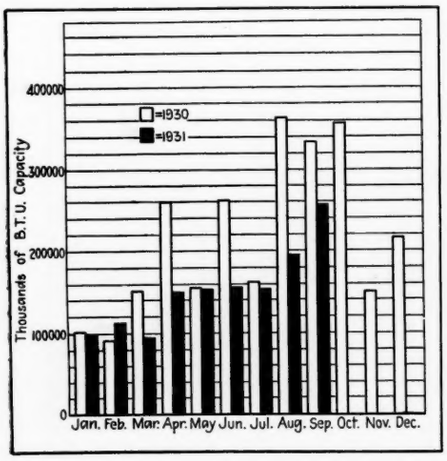


Indirect Heating Surface
Orders in Dollars
September, 1931, $126,790; August, 1931, $75,507; increase, 68%.
(Data not reported prior to January, 1931).

(Continued on page 86)

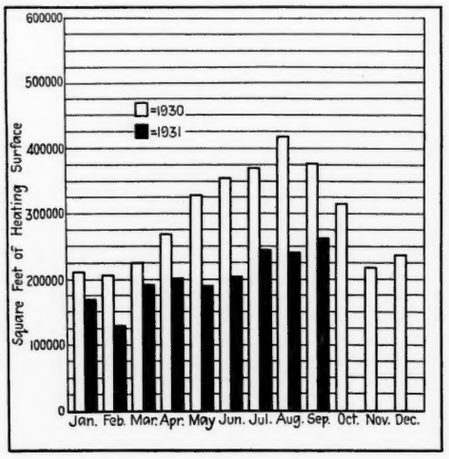
Statistical Service

(Continued from page 85)



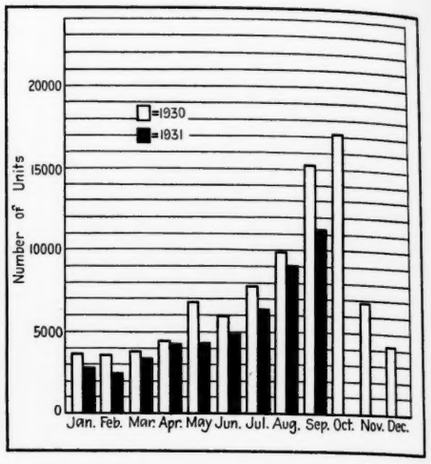
Shipments of Gas-Fired Boilers
In Thousands of B.t.u. Capacity

September, 1931, 257,941; September, 1930, 334,266; decrease over last year, 22.8%; total, nine months, 1931, 1,380,011; total, nine months, 1930, 1,877,375; decrease over last year, 26.4%.



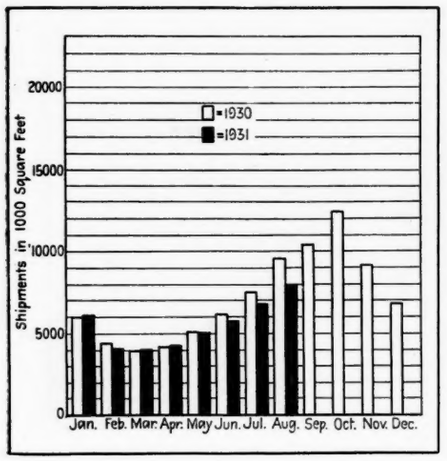
New Orders for Steel Heating Boilers
In Square Feet of Heating Surface

September, 1931, 249,766; September, 1930, 376,917; decrease over last year, 33.7%; total, nine months, 1931, 1,823,241; total, nine months, 1930, 2,775,864; decrease over last year, 34.3%.



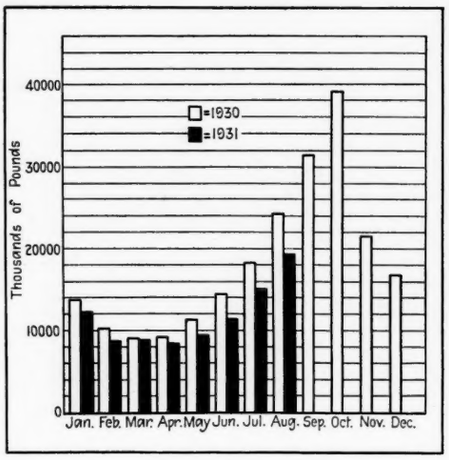
Shipments of Oil Burners
In Number of Units

September, 1931, 11,393; September, 1930, 15,273; decrease over last year, 26.1%; total, nine months, 1931, 49,022; total, nine months, 1930, 60,858; decrease over last year, 19.5%.



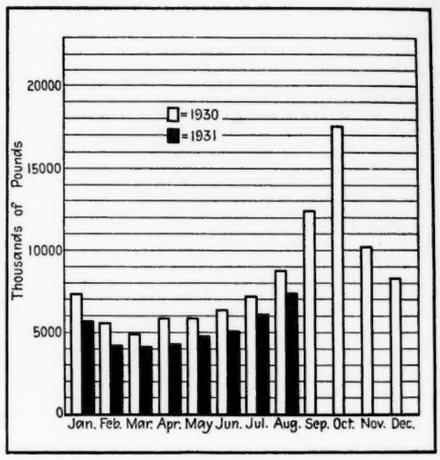
Shipments of Cast Iron Radiators
In 1000 Square Feet

August, 1931, 7960; August, 1930, 9520; decrease over last year, 16.4%; total, eight months, 1931, 44,053; total, eight months, 1930, 46,819; decrease over last year, 5.9%.



Shipments of Cast Iron Square Boilers
In Thousands of Pounds

August, 1931, 19,413; August, 1930, 24,178; decrease over last year, 19.7%; total, eight months, 1931, 93,569; total, eight months, 1930, 110,394; decrease over last year, 15.2%.



Shipments of Cast Iron Round Boilers
In Thousands of Pounds

August, 1931, 7309; August, 1930, 8736; decrease over last year, 16.3%; total, eight months, 1931, 41,432; total, eight months, 1930, 51,850; decrease over last year, 20.1%.

Elsewhere in this issue data are presented showing that the number of installations of gas-fired central heating systems in the country has increased 30.61%. In making comparisons between the shipments of oil burners and the shipments of gas-fired boilers, it should be remembered that the gas-fired equipment will naturally appear more unfavorable due to the fact that the data above are for boilers only, and do not include gas-fired furnaces, whereas the oil burners shipped naturally can be installed in both boilers and furnaces. The result is that the figures above give the impression that less gas-fired equipment is being sold than is actually the case. Similarly, in the case of indirect heating surface, it should be remembered that this figure does not include the heating surface used in industrial unit heaters.

ACCURATE DEPENDABLE CONTROL *for Air Conditioning*

THERMOSTATS—both graduated and positive acting for dry bulb control. **Hygrostats**—both pneumatic and electric for humidity control. **Self Contained Regulators**—complete line for control of air and liquid temperatures. **Brine Control**—regulators for control of brine circulating systems. **Dampers**—both single and multiple blade, with or without operating diaphragm motors. **Diaphragm Valves**—All metal construction, including three-way valves, brine control valves, etc., etc. **Accessories**—Automatic Water Pan for wet bulb control, Relays, Pressure Reducing Valves, Pneumatic Switches, Dial Thermometers, etc., etc.

Write for Bulletin No. 251
which describes Instruments for Air Conditioning Equipment.

THE POWERS REGULATOR COMPANY

40 years of specialization in temperature control
***Offices in 43 Cities*—Chicago, 2720 Greenview Ave.; New York, 231 E. 46th St.; Toronto, 106 Lombard St.**

With the Manufacturers

One Price Policy†

THE most demoralizing feature of a falling market are the wedges of cut price driven into the fair price level. Enough wedges driven in will cause the whole front to give way exactly as in a military operation, but a schedule of prices made in cold blood from cost figures, whether they are higher or lower than that of a competitor, will result at least in a known profit being obtained when an order is booked. If a manufacturer has twenty competitors how can he expect to be low bidder on any considerable percentage of bids offered?

If salesmen are taught that it is not necessary to have the low price in order to make a sale, they will become better salesmen for the reason that their wits must necessarily be sharpened in order to survive. Furthermore, if a manufacturer actually believes, as he professes to believe, that he makes a superior product, why should he not attempt and insist upon a higher price than that quoted for an inferior product? Very few individuals buy for their personal needs the cheapest goods obtainable. They will pay more for shoes, more for clothes, more for an automobile, more for rent than they can buy for. If a manufacturer is buying for his factory, he will pay more for one tool than another can be bought for. He will pay higher salaries than he can get other men for. Should he not, therefore, require his salesmen to educate the public to the points of superiority of his own product and should he not then demand more money for an article worth more money? If not, why not? An individual buying for his personal needs becomes somewhat of an expert in judging quality of shoes, hats, clothes, and is able to differentiate between the qualities of goods offered him. The same thing applies to managers or superintendents of manufacturing establishments regarding tools and men employed by them. In the sale of fans and heaters, however, it happens, unfortunately, too often that the buyer or his agent is too ignorant of technical values to judge the merits of the product which he buys and he must have the intelligent assistance of the seller of the article to enable him to weigh price against quality.

There *is* such a thing as quality. There *is* such a thing as one unit heater being better than another. There *is* such a thing as one fan being better than another. There *is* such a thing as the service of one house being better than that of another. There *is* such a thing as one policy being better than another. It is *not* true that all apparatus is equal and the low price should get the business. Generally speaking, the low price should *not* get the business unless the specifications are exactly followed, and that is never the case in this industry. The workman is worthy of his hire, and the products of a good house should be sold for what they are worth.

† Abstracted from a paper read before the Industrial Unit Heater Association, Swampscott, Mass., June, 1931, by J. F. G. Miller, vice-president, American Blower Corporation.

Stoker Manufacturers Association Issues Condensed Catalog

Forty-eight different types of mechanical stokers, manufactured by the fourteen member companies of the Stoker Manufacturers Association, are illustrated and described in a new forty-page condensed catalog prepared by the association and now available for distribution.

The various stokers are grouped into the following classifications: multiple retort underfeed stokers, single retort underfeed stokers, chain grate stokers and overfeed stokers.

The text is limited to engineering descriptions of the various types of machines, and a supplementary section on engineering data relating to modern stoker practice is included.

Copies will be sent upon request to: W. V. McAllister, secretary, Stoker Manufacturers Association, Foot of Walker St., Detroit, Mich.

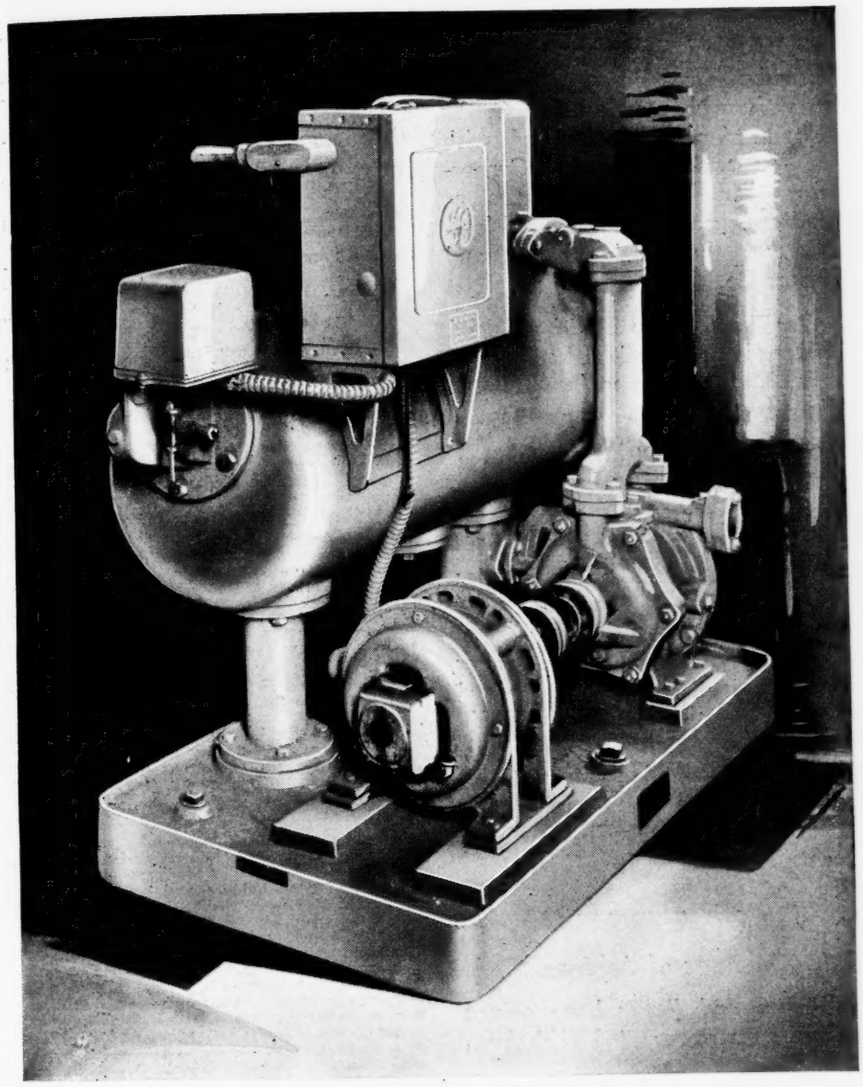
Penn Heat Control Co., Franklin Trust Bldg., Philadelphia, Pa., a subsidiary of the General Electric Co., announces the appointment of Lorin W. Smith, Jr., as New England representative, with offices at 120 Broadway, New York, and 140 Federal St., Boston, Mass.

Mr. Smith was active in the formation of the Committee of Ten of the coal and heating industries, and is now national secretary of that committee.

Kieley & Mueller, Inc., 34 West 13th St., New York, recently purchased a factory at Paris and Niagara Sts., Newark, N. J., in which the company is expected to employ a force of about 100 persons. The plant contains 25,000 sq. ft. of floor space.

Skillful Jennings Design...

affords greater capacity at minimum horsepower



Jennings Vacuum Heating Pumps are furnished in capacities of 4 to 400 g.p.m. of water and 3 to 171 cu. ft. per min. of air. For serving up to 300,000 sq. ft. equivalent direct radiation. Write for Bulletin 85.

Because it does more work and uses less power, the Jennings Vacuum Heating Pump can be depended on to serve efficiently and economically.

Extra Jennings capacity is achieved by means of a unique principle of operation. Air and water are pumped separately so that air capacity is not affected by the volume of water being pumped. Nor is water capacity reduced when air is being handled. The combined air and water capacity of the Jennings Pump is maximum air capacity plus maximum water capacity. This is true of no other heating pump.

A Jennings Vacuum Heating Pump clears the system of air and water rapidly so that it operates only for short periods at a time. It has ample capacity to handle peak loads.

VACUUM PUMPS AND COMPRESSORS FOR AIR AND GAS • RETURN LINE AND AIR LINE VACUUM STEAM HEATING PUMPS • CONDENSATION PUMPS • FLAT BOX PUMPS • CENTRIFUGAL PUMPS • SUCTION (SELF-PRIMING) CENTRIFUGAL PUMPS • SUMP PUMPS • SEWAGE PUMPS • PNEUMATIC SEWAGE EJECTORS

NASH ENGINEERING COMPANY, 81 WILSON ROAD, SO. NORWALK, CONN.

Jennings Pumps

With the Manufacturers

Schutte and Koerting Co., Philadelphia, Pa., has issued Bulletin 11-S describing the company's Radiafin tubes and heating surface used in air heating and cooling. The bulletin contains dimensional and other engineering data of value. Standard size, 8 pages.

Mumford-Hinrichsen, Inc., 400 Madison Ave., New York, has recently been organized by A. F. Hinrichsen, president of A. F. Hinrichsen, Inc., New York, to specialize in the retail sale of portable air conditioning and regulating devices for A. F. Hinrichsen, Inc. W. C. Mumford is president and general manager, and Mr. Hinrichsen is vice-president and chairman of the board of directors.

The Youngstown Sheet and Tube Co., Youngstown, Ohio, has published its Standard Pipe Reference Book, a handbook which contains, in addition to tabular dimensional data on the company's pipe, convenient tables and drawings on pipe uses, applications, etc., of pipe in the heating, ventilating and plumbing fields, compiled by Prof. Samuel E. Dibble. Size 4½ in. x 7½ in. Pp. 85. Available on request.

Foran Boiler Co., Flemington, N. J., has announced the appointment of the following officers: President, Arthur F. Foran; treasurer, H. G. Shields; vice-president and secretary, John F. Schenk; plant manager, Oscar Thomsen; general manager, W. A. Wills.

Reeves Pulley Co., Columbus, Ind., has published its catalog No. 99, describing the line of Reeves variable speed transmissions. The catalog, which contains 74 pages, is particularly complete in regard to illustrations and engineering data pertaining to applications of the company's products.

American Foundry & Furnace Co., Bloomington, Ill., has appointed W. W. Hoopes district sales manager of the gas division for Ohio and adjacent territory.

C. A. Dunham Co., 450 E. Ohio St., Chicago, Ill., has issued Bulletin No. 510 on Dunham Type L concealed radiators. It is designed for engineers, architects and contractors and gives unusually complete dimensional and capacity data, piping details, suggested specifications and other specific information of value in the drafting room and in the field. Standard size, 32 pages.

Sundstrand Engineering Co., 280 Columbus Ave., Boston, Mass., has been formed recently by C. E. Hooper, formerly connected with the Keystone Engineering Corporation. Mr. Hooper will represent the Sundstrand Sales Co., Rockford, Ill., and the Leader Boiler and Heater Co., Decatur, Ill.

Gar Wood Boiler Division, Wood Hydraulic Hoist and Body Co., Detroit, Mich., has appointed T. D. Kingsley general sales manager.

The Duriron Co., Inc., Dayton, Ohio, announces the following appointments: H. P. Rodgers, as Cleveland representative, with offices located at 528 Leader Building; E. J. Healy as representative for the building equipment department, in Washington, D. C.; G. A. Baker as manager of the recently opened direct sales office in Buffalo, N. Y., with offices at 220 Delaware Ave. The Industrial Equipment Company, formerly representing the Duriron Company in Buffalo, has been dissolved.

Changes of Address

Slocum and Fuller have moved to larger quarters at 489 Fifth Ave., New York.

Richardson & Boynton Company recently moved from 260 Fifth Avenue, to larger quarters at 244 Madison Ave., New York, where its New York Branch, general display room and headquarters will be housed.

Richardson & Boynton Co., Boston, Mass., Branch, has moved the management and selling divisions of its office from 80 Federal Street to 17 Farnsworth Street.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF HEATING AND VENTILATING, published monthly at New York, N. Y., for October 1, 1931.

State of New York, County of New York, ss.:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Edgar A. Becker, who, having been duly sworn according to law, deposes and says that he is the Treasurer of The Industrial Press, publishers of Heating and Ventilating and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press, 140-148 Lafayette St., New York, N. Y.

Editor, C. H. B. Hotchkiss, 140-148 Lafayette St., New York, N. Y.

Managing Editor, Clifford Strock, 140-148 Lafayette St., New York, N. Y.

Business Managers, Robert B. Luchars, 140-148 Lafayette St., New York, N. Y.; Edgar A. Becker, 140-148 Lafayette St., New York, N. Y.; Erik Oberg, 140-148 Lafayette St., New York, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

The Industrial Press, 140-148 Lafayette St., New York, N. Y.; Estate of Alexander Luchars, 140-148 Lafayette St., New York, N. Y.; Louis Pelletier, 140-148 Lafayette St., New York, N. Y.; Erik Oberg, 140-148 Lafayette St., New York, N. Y.; Robert B. Luchars, 140-148 Lafayette St., New York, N. Y.; Edgar A. Becker, 140-148 Lafayette St., New York, N. Y.; Laura A. Brownell, 140-148 Lafayette St., New York, N. Y.; Franklin D. Jones 140-148 Lafayette St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner: and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

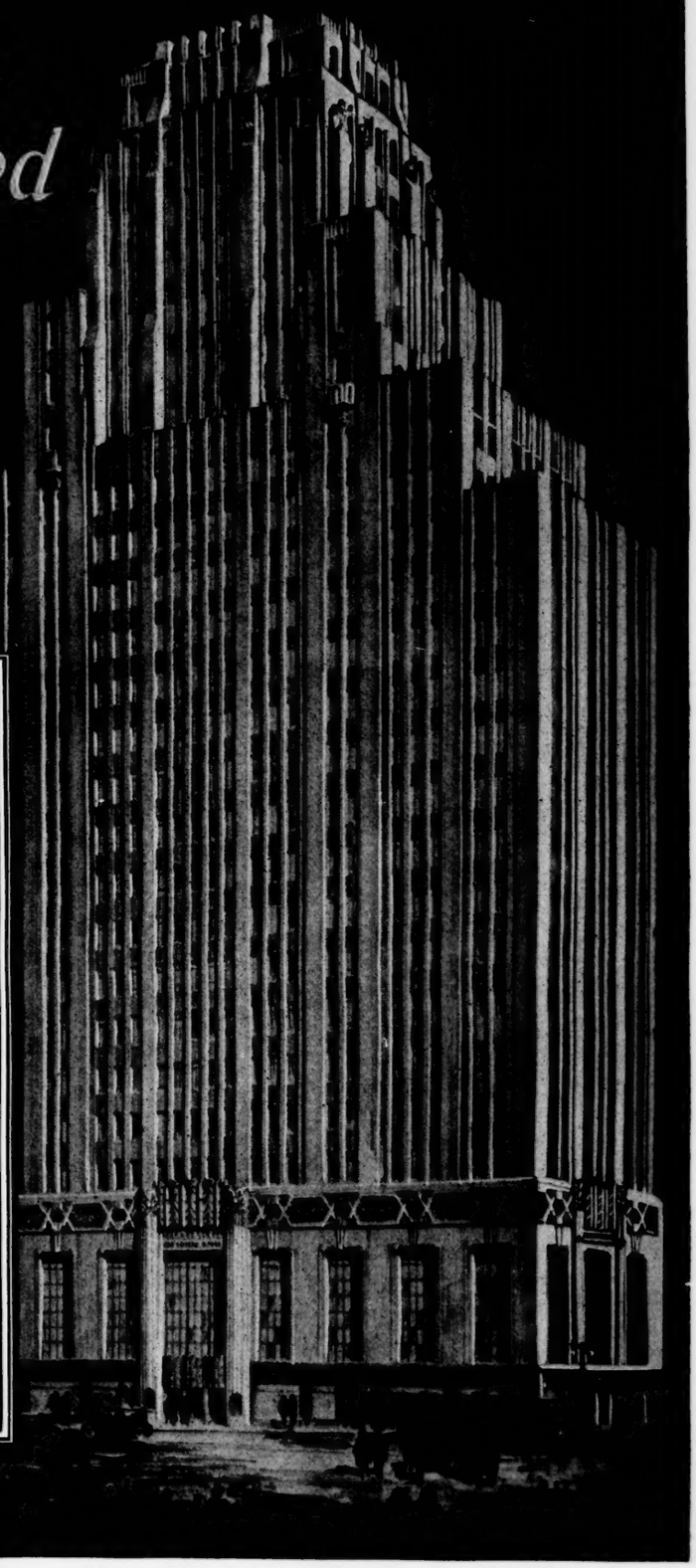
EDGAR A. BECKER, Treasurer

Sworn to and subscribed before me this 17th day of September, 1931.

CHARLES P. ABEL

Notary Public
Kings County No. 210
Kings Register No. 3011
N. Y. County No. 15
N. Y. Register No. 3-A-6
My Commission Expires
March 30, 1933.

Honoring a Distinguished Location



MARKET STREET NATIONAL BANK BUILDING
Philadelphia, Pa.
Architects: Ritter & Shay
Plumbing & Heating Contractor: Wm. M. Anderson

At the apex of the "golden triangle" in Philadelphia, the new Market Street National Bank has a proud position and occupies it well. Standing at the very center of the mercantile, financial, and governmental life of the city, and with the principal railway stations, hotels, and theatres only a few steps away, it towers above neighboring structures and has light, air, and outlook. Its style is both dignified and modern. Its plan and equipment embody all that is most approved and most desirable in an office building. As a whole, its distinction is evident.

The choice of any material for use in such a project is a recognition of undoubted merit in that material. In the Market Street Bank Building, the major pipe tonnage is NATIONAL—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY
Subsidiary of United States Steel Corporation
PITTSBURGH, PA.

US STEEL

NATIONAL PIPE

Degree Days and Unit Fuel Consumption in Typical Cities

October, 1931

UNIT fuel consumption figures given below must be corrected for efficiency, heat content of fuel other than that listed below, for radiation emitting other than 240 B.t.u. per hr., and for radiation calculated on a basis other than zero outside to 70° inside.

Coal is assumed as having a heat content of 12,000 B.t.u. per lb., gas, 1000 B.t.u. per cu. ft., and oil, 140,000 B.t.u. per gal. To correct for other heating values, multiply the fuel consumption listed under the charts by the standard heat content just listed, and divide by the heat content of the fuel actually being used in the installation being calculated.

For radiation installed for any other outside temperature than zero, multiply the fuel consumption given under the charts by 70°, divided by the quantity (70 minus the outside temperature used).

To correct for efficiency, divide the fuel consumption by the efficiency of the heating installation.

For water radiation, multiply the fuel consumption which is given for steam radiation by 5/8.

	New York	Seattle	San Francisco	Chicago	Denver	Boston	St. Louis	Pittsburgh	Minneapolis
Degree days	180	385	176	224	338	220	168	267	337
Total degree days since September 1	202	550	275	266	394	291	184	316	398
Lb. of coal per sq. ft. of radiation this month	1.440	3.080	1.408	1.791	2.705	1.760	1.344	2.136	2.600
Gal. of oil per sq. ft. of radiation this month	0.123	0.264	0.121	0.154	0.232	0.151	0.115	0.184	0.232
Cu. ft. of gas per sq. ft. of radiation this month	17.28	37.00	16.90	21.50	32.40	21.13	16.13	25.65	32.35

(See Footnote)

	Los Angeles	Baltimore	Philadelphia	New Orleans	Atlanta	Cleveland	Cincinnati	Detroit
Degree days	27	124	133	8	81	235	209	267
Total degree days since September 1	27	134	146	8	94	282	249	315
Lb. of coal per sq. ft. of radiation this month	0.216	0.992	1.064	0.064	0.648	1.880	1.673	2.135
Gal. of oil per sq. ft. of radiation this month	0.019	0.085	0.091	0.005	0.056	0.161	0.143	0.183
Cu. ft. of gas per sq. ft. of radiation this month	2.59	11.90	12.77	0.77	7.78	22.57	20.01	25.60

(See Footnote)

	Buffalo	Birmingham	Indianapolis	Memphis	Des Moines	Kansas City	Louisville	Galveston
Degree days	301	57	216	75	236	159	152	4
Total degree days since September 1	362	59	248	79	285	172	174	4
Lb. of coal per sq. ft. of radiation this month	2.410	0.456	1.730	0.600	1.890	1.272	1.216	0.032
Gal. of oil per sq. ft. of radiation this month	0.207	0.039	0.148	0.051	0.162	0.109	0.104	0.003
Cu. ft. of gas per sq. ft. of radiation this month	28.93	5.47	20.75	7.20	22.66	15.26	14.59	0.38

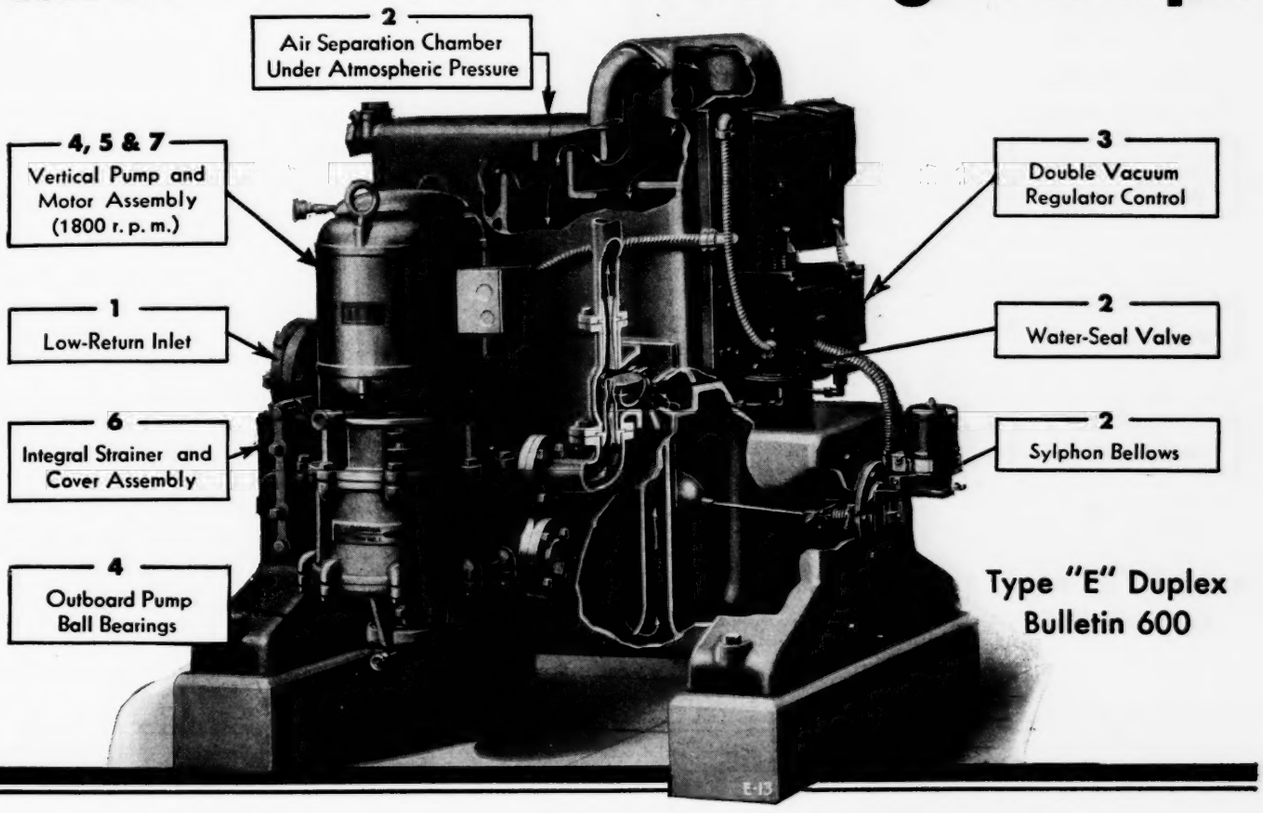
(See Footnote)

Fuel consumption figures must be corrected for local conditions as explained above.

SOME *Facts* ABOUT

Ad No. 10 in Series

LOW-RETURN Ames Vacuum Heating Pumps



Type "E" Duplex Bulletin 600

Types "E" and "F" Pumps will be on exhibition in Booths Nos. 448 and 450 at the International Heating & Ventilating Exposition — January 25th-29th, 1932—at Cleveland.

1. LOW RETURNS UNDER FLOAT CONTROL
2. PROOF AGAINST AIR LEAKAGE INTO SYSTEM
3. DOUBLE VACUUM REGULATOR CONTROL
4. BALANCED VIBRATIONLESS OPERATION
5. ELIMINATION OF PUMP AND MOTOR MISALIGNMENT
6. PROOF AGAINST OPERATING WITHOUT STRAINER
7. REDUCED FLOODING HAZARD OF MOTORS
8. REDUCED FLOOR SPACE AND INSTALLATION COST

AMES PUMP COMPANY, INC.

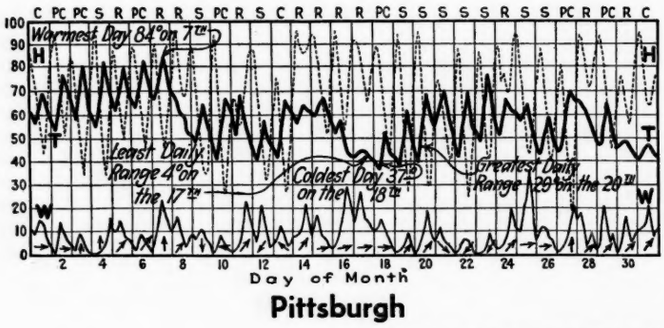
30 Church Street **New York, N. Y.**

DIVISION OF AMERICAN LOCOMOTIVE COMPANY

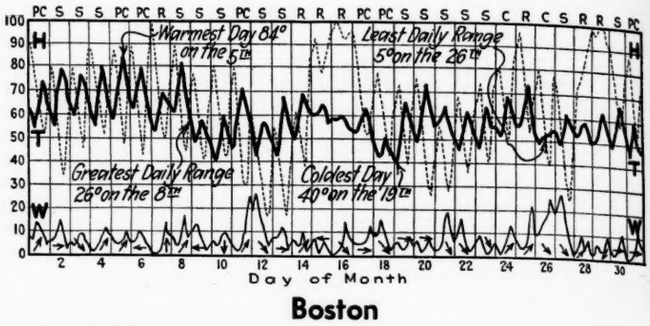
Representatives in All Principal Cities

The Weather

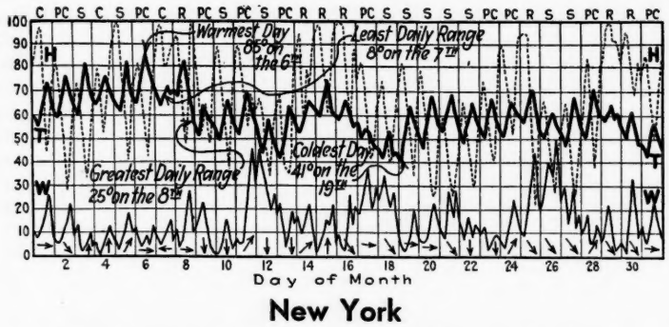
October, 1931


Warmest Day 84° on 7th
Least Daily Range 4° on the 17th
Coldest Day 37° on the 18th
Greatest Daily Range 29° on the 20th
Day of Month

Pittsburgh

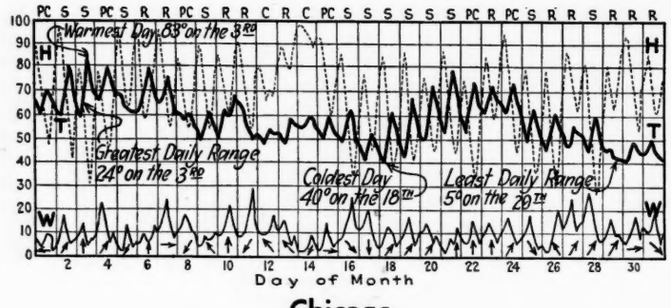

Warmest Day 84° on the 5th
Least Daily Range 5° on the 26th
Greatest Daily Range 26° on the 8th
Coldest Day 40° on the 19th
Day of Month

Boston

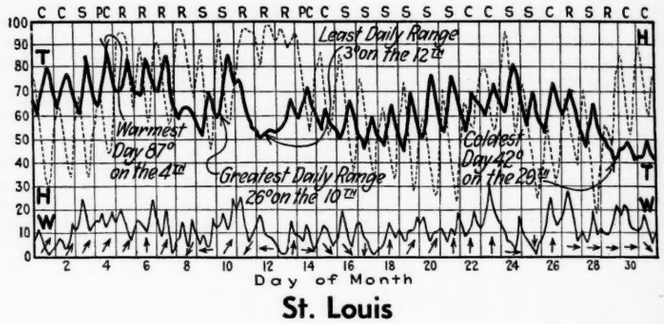

Warmest Day 85° on the 6th
Least Daily Range 8° on the 7th
Coldest Day 41° on the 19th
Greatest Daily Range 25° on the 8th
Day of Month

New York

(Hourly Observation of the Relative Humidity Plotted on this Chart)


Warmest Day 83° on the 3rd
Greatest Daily Range 24° on the 3rd
Coldest Day 40° on the 18th
Least Daily Range 5° on the 26th
Day of Month

Chicago


Least Daily Range 3° on the 12th
Warmest Day 87° on the 4th
Greatest Daily Range 26° on the 10th
Coldest Day 42° on the 29th
Day of Month

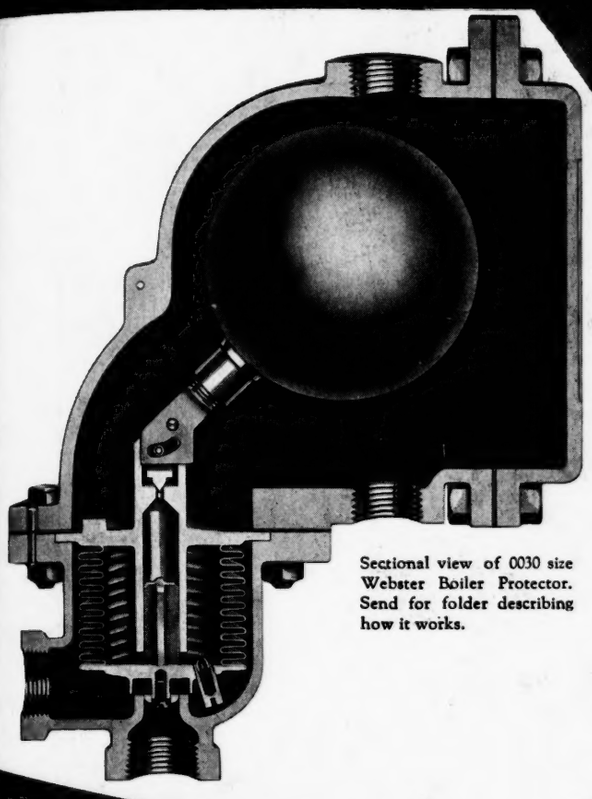
St. Louis

	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, deg. F.	85	84	84	83	87
Date of highest temperature	6	5	7	3	4
Lowest temperature, deg. F.	41	40	37	40	42
Date of lowest temperature	19	19	18	18	29
Greatest daily range, deg. F.	25	26	29	24	26
Date of greatest daily range	8	8	20	3	10
Least daily range, deg. F.	8	5	4	5	3
Date of least daily range	7	26	17	29	12
Mean temperature for month, deg. F.	60.4	58.5	57.4	58.8	62.9
Normal mean temperature for month, deg. F.	56.3	53.6	55.6	54.0	58.8
Total precipitation, this month, inches	2.87	2.18	1.21	2.62	2.90
Total snowfall, this month, inches	0	0	0	0	0
Normal precipitation, this month, inches	3.53	3.15	2.52	2.53	2.72
Total wind movement, this month, miles	9,474	5,055	5,443	6,965	8,299
Average hourly wind velocity, miles	12.7	6.8	7.3	9.4	11.2
Prevailing direction of wind	N.W.	N.W.	S.W.	S.W.	S.
Number of clear days	11	15	9	12	13
Number of partly cloudy days	12	9	8	8	6
Number of cloudy days	8	7	14	11	12
Number of days with precipitation	11	7	11	11	10
Number of days with snowfall	None	None	None	None	None
Snow on ground, at end of month	None	None	None	None	None

Plotted from records especially compiled for HEATING AND VENTILATING by the United States Weather Bureau.
Heavy lines indicate temperatures in degrees F. Light lines indicate wind in miles per hour.
Broken lines indicate humidity in percentage from readings at 8 a. m., 12 m., and 8 p. m.
S—clear, PC—partly cloudy, C—cloudy, R—rain, Sn—snow. Arrows fly with prevailing directions of wind.

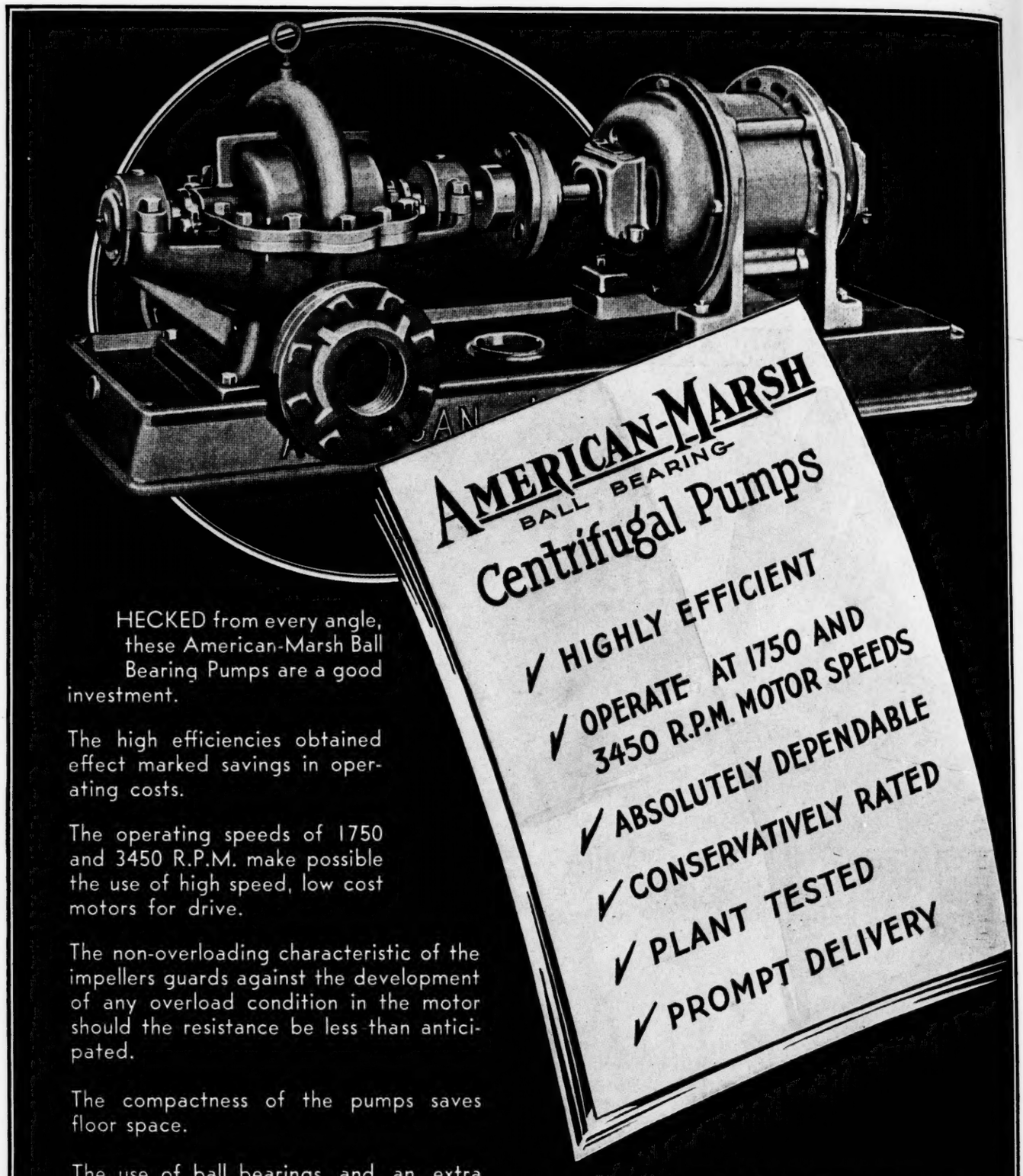
Heating and Ventilating

DECEMBER, 1931



Sectional view of 0030 size Webster Boiler Protector. Send for folder describing how it works.

that increased use of motor-
has increased the
Now,



HECKED from every angle, these American-Marsh Ball Bearing Pumps are a good investment.

The high efficiencies obtained effect marked savings in operating costs.

The operating speeds of 1750 and 3450 R.P.M. make possible the use of high speed, low cost motors for drive.

The non-overloading characteristic of the impellers guards against the development of any overload condition in the motor should the resistance be less than anticipated.

The compactness of the pumps saves floor space.

The use of ball bearings and an extra strong, rugged construction throughout insure long service life and low maintenance.

American-Marsh Ball Bearing Centrifugal Pumps are built single and two-stage; in sizes 1½ to 12inch. They are conservatively rated, plant tested and guaranteed. We recommend them to you as being absolutely O.K. Write for Bulletin 61.

AMERICAN STEAM PUMP COMPANY

Established 1873

BATTLE CREEK, MICHIGAN

SALES OFFICES IN PRINCIPAL CITIES

HEATING AND VENTILATING, *formerly* HEATING AND VENTILATING MAGAZINE, published monthly by THE INDUSTRIAL PRESS, 148 Lafayette Street, New York, N. Y. Subscription rates: United States, $2.00; Canada, $2.50; Foreign, $3.00. Single copies, 30 cents. Vol XXVIII, No. 12, December, 1931. Entered as second-class matter, April 18, 1925, at the Post Office at New York, N. Y., under the Act of March 3, 1879.
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A. S. GODDARD

PLUMBING AND HEATING

27 NORTH BROADWAY

NYACK, N. Y.

November 11, 1931

McDonnell & Miller,
Wrigley Building,
Chicago, Illinois.

Gentlemen:

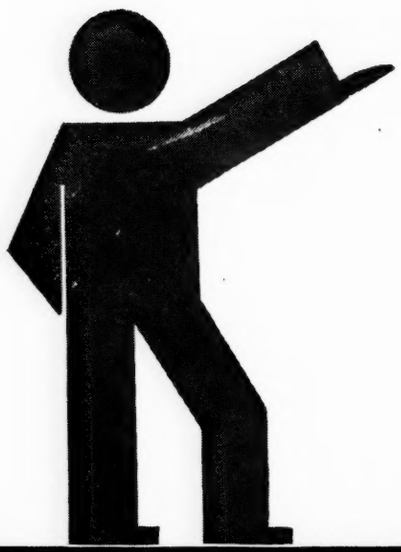
I am well pleased with the number 30 Safety Feeder I installed at Mr. Ables Building. It has been on two years, and is going fine and giving perfect service. I know of no better control and your service and advice is very good.

I appreciate your promptness greatly.

Very truly yours,

A. S. Goddard.

ANNOUNCING!



another outstanding in the design of

AN IMPROVED CORRUGATION

A STRONGER, MORE DURABLE METAL

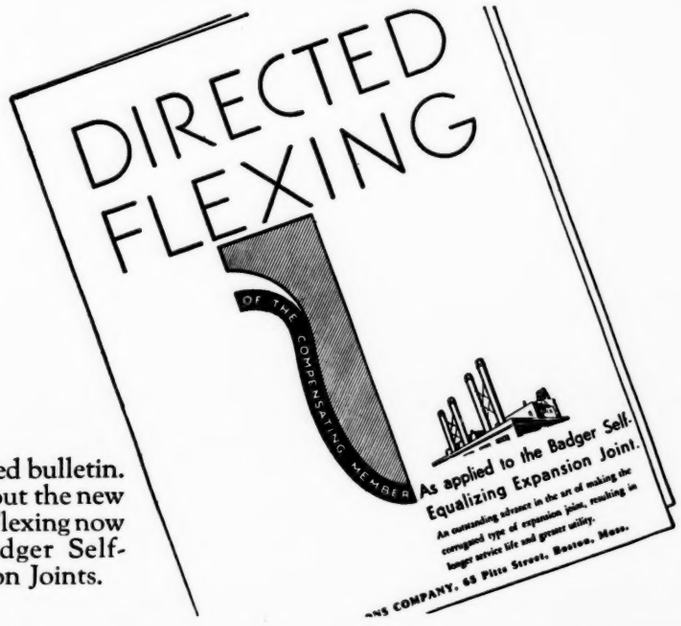
Familiar Features of the Badger Self-Equalizing Expansion Joints

no packing used, hence no maintenance

compactness and ease of installation

monel metal sleeve for superheated steam

choice of welding or flanged ends


DIRECTED FLEXING
OF THE COMPENSATING MEMBER
As applied to the Badger Self-Equalizing Expansion Joint.
An outstanding advance in the art of making the corrugated type of expansion joint, resulting in longer service life and greater utility.

Send for this illustrated bulletin. It tells in detail all about the new principle of Directed Flexing now embodied in all Badger Self-Equalizing Expansion Joints.

improvement by BADGER of expansion joints . . .

DIRECTED FLEXING

of the compensating member

THE secret of being able to flex a piece of sheet metal interminably is in completely distributing the stresses. Keep these stresses from concentrating in one or more spots and the life of the metal is greatly prolonged.

This is the action and result brought about by the *new* design of corrugation and equalizing ring for the Badger Expansion Joint. Each corrugation is entirely curved and during flexing remains curved. There are no places where stresses can localize. The movement is undulating throughout. "Directed Flexing" expresses the whole action precisely. Longer life is the result.

And with the development of this new corrugation came the application of a new metal, Everdur, which has all the advantages of copper and in addition is stronger, more durable and more resilient. These properties make it possible to meet higher pressures and to take care of more expansion and contraction.

This important improvement—the latest of several brought out by Badger engineers—means still lower maintenance costs for those equipping steam lines with expansion joints. As with all Badger Joints, there is no servicing.

Write to the nearest Badger office for descriptive folder and for prices and deliveries.

E. B. BADGER & SONS COMPANY

67 PITTS STREET, BOSTON, MASS.

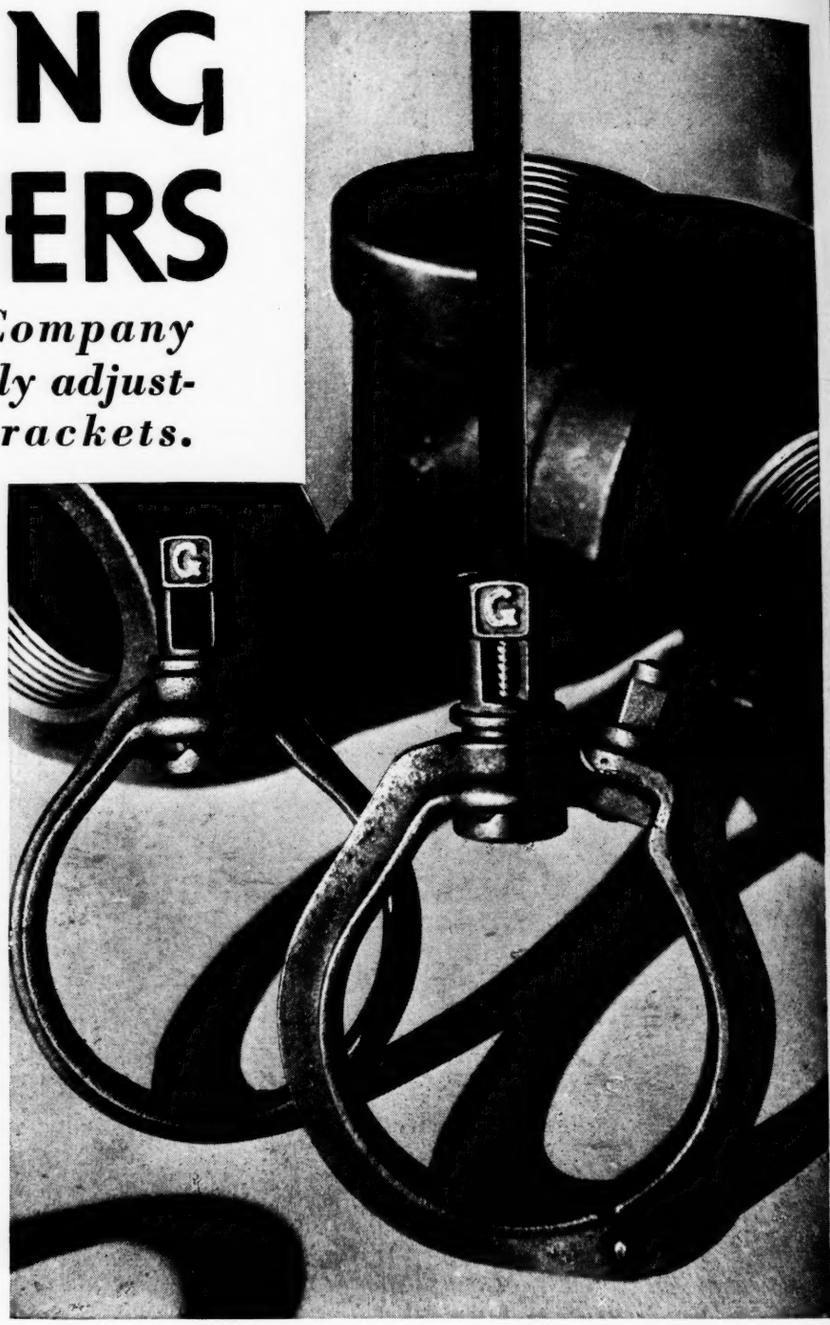
BADGER EXPANSION JOINTS

BRANCHES

Atlanta, Georgia, 140 Edgewood Ave.
Charlotte, N. C., 1408 Independence Building
Chicago, Ill., 2831 South Parkway
Cincinnati, Ohio, Union Trust Bldg.
Cleveland, Ohio, Guardian Building
Detroit, Mich., 402 Ford Building
Houston, Tex., 1308 Sec. Nat. Bk. Bldg.
Indianapolis, Ind., 823 Occidental Bldg.
Kansas City, Mo., 1336 Oak Street
Los Angeles, Cal., 517 Hollingsworth Building
Minneapolis, Minn., 732 Build. Exch.
Montreal, Que., Can. Cement Bldg.
New Orleans, La., 419 Maritime Bldg.
New York City, 271 Madison Ave.
Philadelphia, Pa., 1500 Walnut St. Room 901
Pittsburgh, Pa., Union Trust Bldg.
Salt Lake City, Utah, Kearns Bldg.
San Francisco, Cal., Sharon Bldg.
Seattle, Wash., Smith Tower
St. Louis, Mo., 3605 Laclede Avenue

LEADING ENGINEERS

know why Grinnell Company designed a line of easily adjustable hangers and brackets.

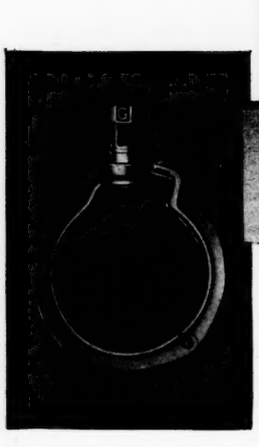


The need for quick and accurate adjustment of Automatic Sprinkler pipe lines was largely responsible for the development of the Grinnell line of brackets and adjustable hangers.

Speedy installation is what makes profits these days. The quicker the pipe is hung the sweeter the profits!

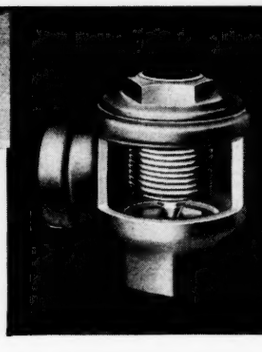
By turning an adjusting nut on a Grinnell hanger, your workman levels his line easily and accurately as fast as it is hung. When finished, your installation is the pride of the owner. The architect wants your bids on his next jobs.

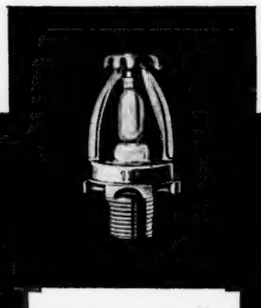
ALL THESE GRINNELL PRODUCTS



Pipe fittings, cast and malleable, perfectly threaded, accurately machined and rigidly inspected. Pipe hangers adjustable after the pipe is up. Reduce installation costs and maintenance expense.

This trap, with the famous Hydron Bellows, will operate a radiator for a lifetime without repairs.





The famous Quartz bulbsprinkler head. In most cases sprinklers will reduce insurance expense from 50 to 90 percent.

Where air dryness adversely affects processes, large savings are made by our humidification equipment.

ARCHITECTS OF AMERICA know why

Grinnell Company has never made ordinary cast and malleable fittings.

Since super-quality fittings are needed for automatic sprinkler work, that is the standard for all fittings made by Grinnell.

Contractors prefer Grinnell fittings because of ease and speed of installation work. Building owners specify them because they want fine appearance and low maintenance. This applies equally to both the Grinnell cast and malleable lines.

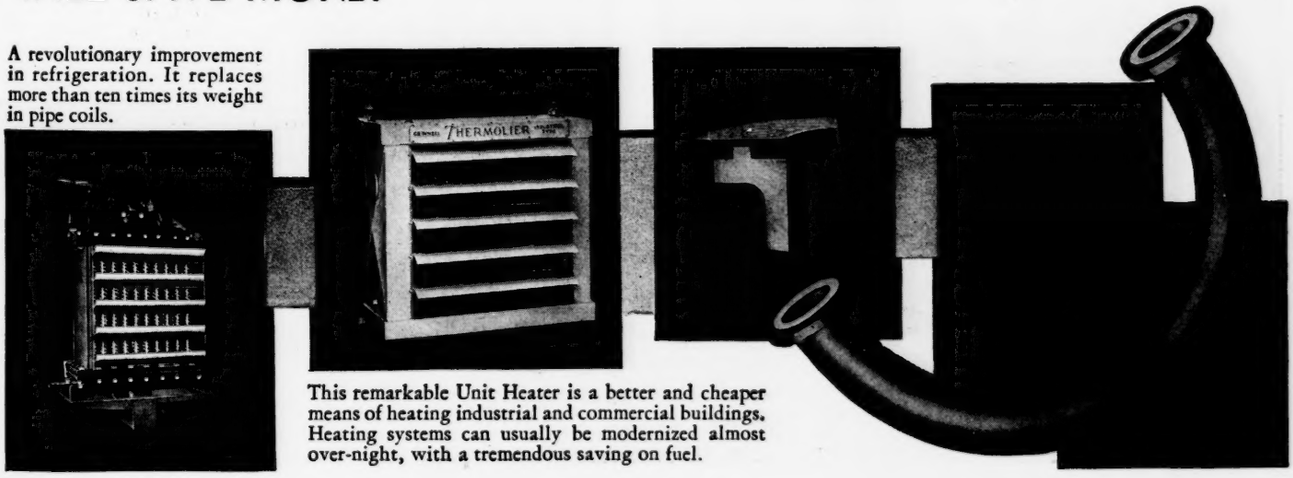
GRINNELL COMPANY INC.

Branches in all principal cities

Executive Offices: Providence, R. I.

WILL SAVE MONEY

A revolutionary improvement in refrigeration. It replaces more than ten times its weight in pipe coils.



This remarkable Unit Heater is a better and cheaper means of heating industrial and commercial buildings. Heating systems can usually be modernized almost over-night, with a tremendous saving on fuel.

Keep his head up

and we'll all come through!

You recognize this man. He lives in your own town, not far from you . . .

Though faced with unemployment, he is combating adversity with courage. He has retreated step by step, but fighting. He has spread his slender resources as far as they will go.

This winter he and his family will need your help.

There are many other heads of families much like him in the United States. This winter all of them will need the help of their more fortunate neighbors.

This is an emergency. It is temporary. But it exists. It must be met with the hopefulness and resource typical of American conduct in emergencies.

Be ready! Right now in every city, town and village, funds are being gathered for local needs—through the established welfare and relief agencies, the Community Chest, or special Emergency Unemployment Committees . . .

The usual few dollars which we regularly give will this year not be enough. Those of us whose earnings have not been cut off can and must double, triple, quadruple our contributions.

By doing so we shall be doing the best possible service to ourselves. All that America needs right now is courage. We have the resources. We have the man power. We have the opportunity for world leadership.

Let's set an example to all the world. Let's lay the foundation for better days that are sure to come.

The President's Organization on Unemployment Relief

Walter S. Gifford

WALTER S. GIFFORD, DIRECTOR
Committee on Mobilization of Relief Resources

Owen D. Young

OWEN D. YOUNG, CHAIRMAN

The President's Organization on Unemployment Relief is non-political and non-sectarian. Its purpose is to aid local welfare and relief agencies everywhere to provide for local needs. All facilities for the nation-wide program, including this advertisement, have been furnished to the Committee without cost.

PLAIN TALKS ON OIL BURNER PROFITS

No. 19—Profits for the Small Town Dealer

OIL burner profits are by no means restricted to dealers located in metropolitan areas with large sales organizations. The dealer in the small town has just as good an opportunity to make a substantial profit with the Electrol plan.

Before climbing onto the Electrol bandwagon one year ago, Mr. Frank S. McHugh, of Wolfeboro, N. H., had handled several different makes of oil burners with indifferent success. Although Wolfeboro is a town of less than 2500 people, in one short year he has hung up a record of substantial profits.

In the surrounding territory Mr. McHugh has already established eighteen branch sales offices. He has welded together an aggressive sales organization that is giving a good account of itself.

"When your customers are as widely scattered as mine are," writes Mr. McHugh, "it is important to have an oil burner that requires a minimum of servicing. In my experience, Electrol is the one oil burner that fully meets this qualification."

If you live in a small town and are the type of man who can work hard to cash in on a real opportunity, Electrol has a plan that will interest you. Send the coupon below for full information.

For the Heating Contractor—a Two-Way Profit

1. THE ELECTROL FRANCHISE. There's a nice profit in the Electrol Franchise for the Heating Contractor. This is abundantly proved by the success achieved by many leaders in the business.

2. THE ELECTROL COOPERATIVE PLAN. You will find the Electrol dealer in your territory prepared to make an attractive cooperative arrangement. One that adds to your income; safeguards your professional reputation and requires no extra investment. Let us give you details.

Quiet All-Electric ELECTROL Oil Burner

Member of the Oil Heating Institute

New York Office: 227 E. 45th St. *Factory:* ST. LOUIS

Branches

NEW YORK ST. LOUIS MINNEAPOLIS
BOSTON CHICAGO SEATTLE

ELECTROL

The OIL BURNER *with the Master Control*

227 East 45th Street, New York City

ELECTROL, INC.,
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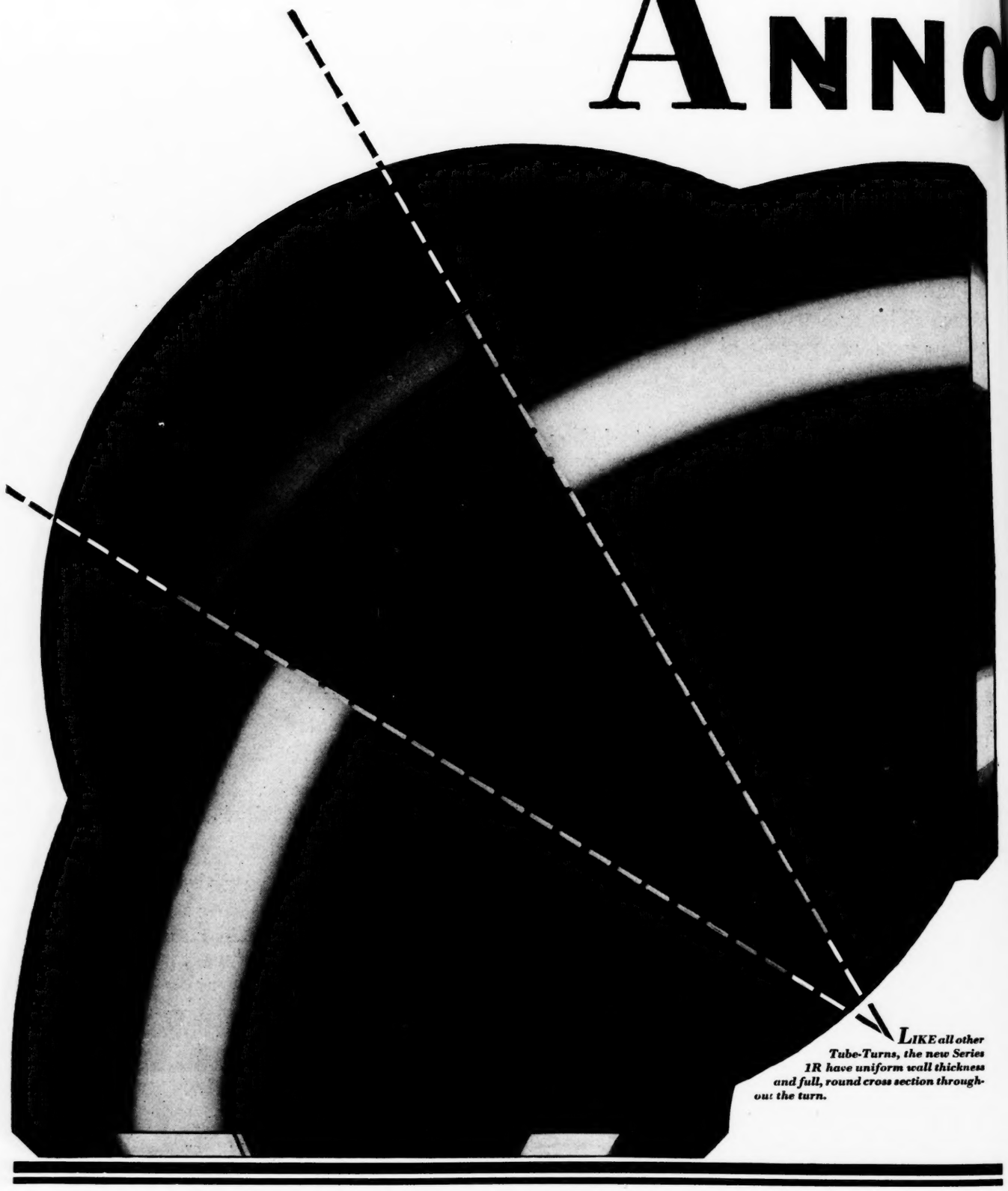

LIKE all other Tube-Turns, the new Series 1R have uniform wall thickness and full, round cross section throughout the turn.

The new Series 1R Tube-Turns, added to the three already-established Tube-Turns Series (1½R, 1½RX and O. D.) now make available to you a complete line of fittings for welding, complete in sizes and weights that meet virtually every need for modern piping.

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TODAY the new Series 1R Tube-Turns take their place in the Tube-Turn line—a new series of the *original* fittings for pipe welding. Today you can buy genuine, *seamless* Tube-Turns *at greatly reduced prices*—and still get ALL the exclusive advantages found *only* in genuine Tube-Turns.

FIRST **—You *still* get ideally strong, *seamless* fittings made by the exclusive Tube-Turn process, from *seamless* tubing.**

SECOND **—You *still* get uniform wall thickness—no thinning or stretching of outside walls—no thickening or compression of inside walls—full pipe size throughout the turn.**

THIRD **—You *still* get fittings that exactly match the pipe in outside diameter, inside diameter, wall thickness and wall tolerance—fittings that line up at all points.**

FOURTH **—You *still* get fittings that are made on a *constant* radius—easy to design, easy to calculate for pressure-loss.**

FIFTH **—You *still* get fittings which are free from the corrosion-inviting structure set up by bending and similar processes.**

SIXTH **—You *still* get fittings that can be cut to form elbows of any desired angle.**

SEVENTH **—You *still* get fittings which are neither bends, stampings nor castings.**

EIGHTH **—You *still* get the fittings that are proved by years of use and which are accepted as the *standard* of comparison.**

Today this new addition to Tube-Turns' line is now in the stocks of distributors... Write *today* for full descriptions and specifications—and *prices*. The coupon is for your convenience.

Address: **Tube-Turns, *Incorporated*, 1319 Shelby Street, Louisville, Kentucky.**

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The name Tube-Turn applies ONLY to the original, genuine products made by Tube-Turns, Incorporated.

TUBE-TURNS, *Incorporated*, 1319 Shelby St., Louisville, Ky. *Gentlemen:* Please send me, immediately and without obligation, full specifications and prices on Series 1R Tube-Turns.

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City ..... **State** .....

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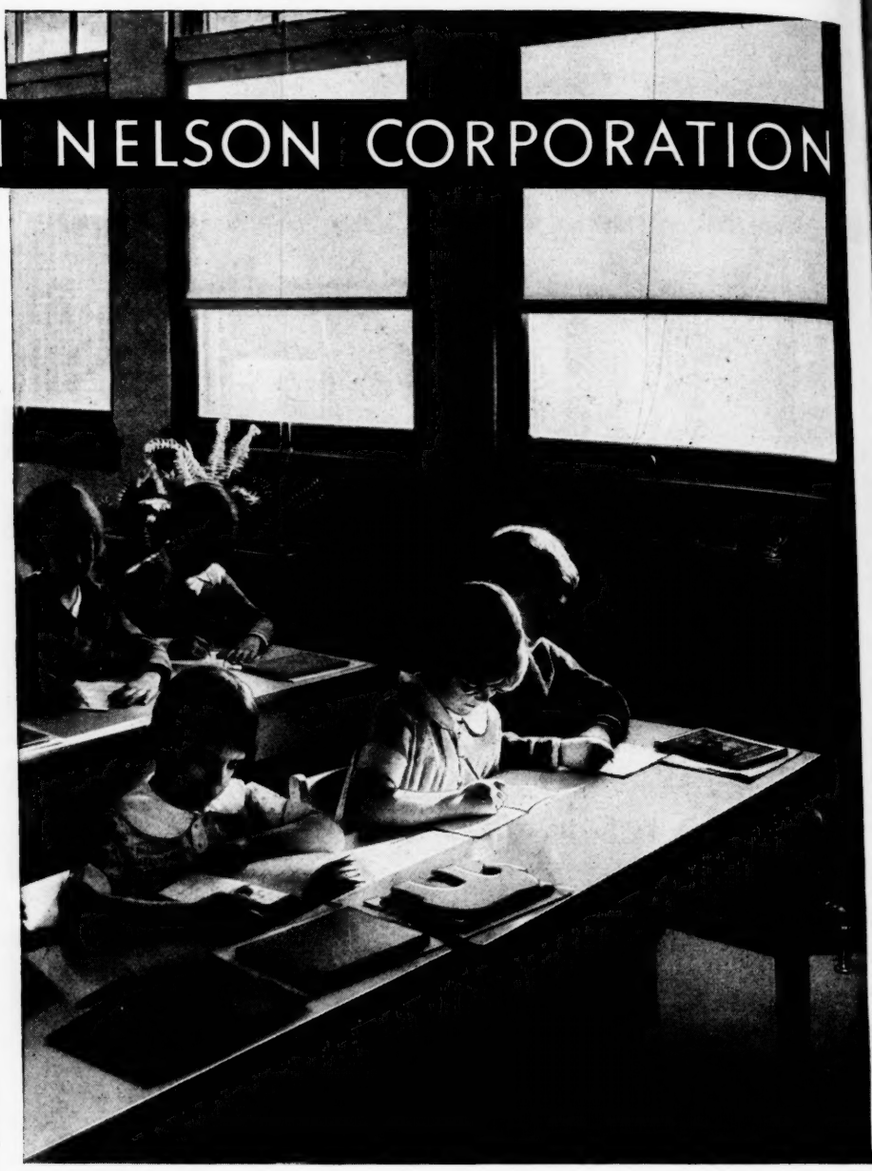
THE HERMAN NELSON CORPORATION



HERMAN NELSON

HER-NEL-CO

SYSTEM OF VENTILATION

The Herman Nelson Corporation are makers of the *Univent System of Ventilation*, the *Her-Nel-Co System of Ventilation*, the *Herman Nelson Invisible Radiator*, the *Herman Nelson hi Jet Heater*, and other heating and ventilating equipment.

Engineers, architects and school authorities see in the Her-Nel-Co System of Ventilation the practical solution of a most harassing problem.

In this system an invigorating, healthful atmosphere is created and maintained in the school room—without the expensive expedient of preheating a continuous supply of outdoor air.

It is estimated that the Her-Nel-Co operates at 50% of the fuel costs of systems based on supplying the school room with a fixed quantity of outdoor air—irrespective of outside weather conditions. Naturally this modern system also effects decided savings in boiler costs, radiator costs, and building costs.

School authorities, engineers, and architects interested in securing better ventilation, at a saving in fuel, maintenance and building costs, should write for the book, "The Herman Nelson Her-Nel-Co System of Ventilation".

A HERMAN NELSON PRODUCT

Factory at Moline, Illinois • *Sales and Service Offices in All Principal Cities*

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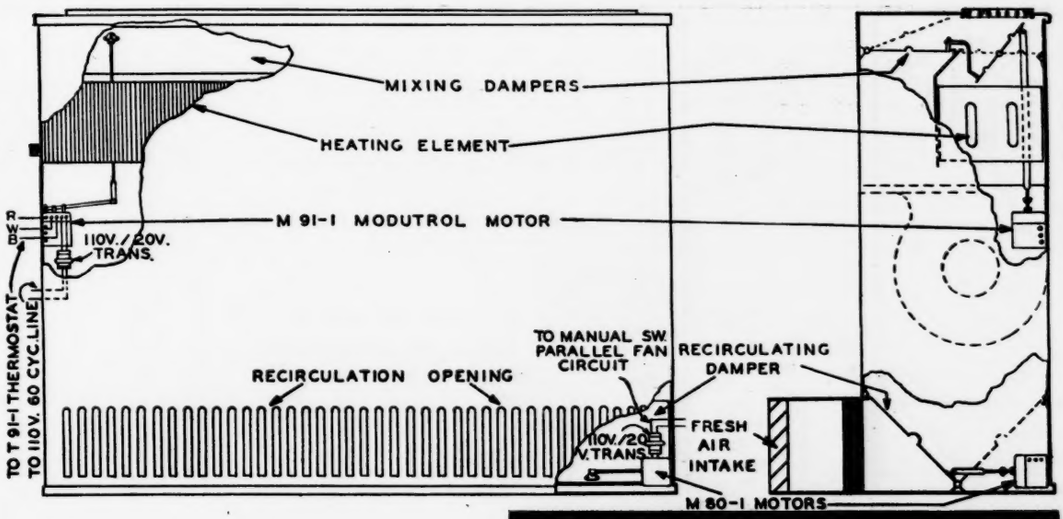
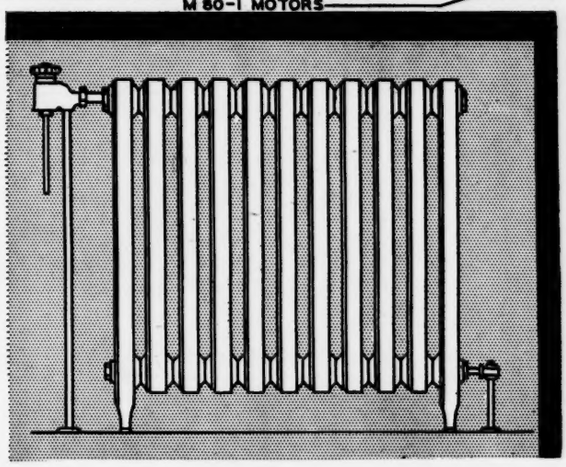
BOSTON	KINGSTON, PA.	SAGINAW, MICH.	MILWAUKEE	DALLAS	LOS ANGELES
SPRINGFIELD, MASS.	HARRISBURG	DETROIT	APPLETON, WIS.	OMAHA	VANCOUVER, B. C.
PROVIDENCE, R. I.	PITTSBURGH	CLEVELAND	MINNEAPOLIS	EMPORIA, KAN.	TORONTO, ONT.
HARTFORD, CONN.	JOHNSTOWN, PA.	COLUMBUS	DULUTH	KANSAS CITY	WINNIPEG, MAN.
NEW YORK CITY	ALLENTOWN, PA.	CINCINNATI	ST. LOUIS	DENVER	CALGARY, ALTA.
SYRACUSE	ERIE, PA.	TOLEDO	BIRMINGHAM	SALT LAKE CITY	LONDON
ALBANY	WHEELING, W. VA.	INDIANAPOLIS	NASHVILLE	BUTTE, MONT.	OSLO
ROCHESTER	WASHINGTON, D. C.	EVANSVILLE, IND.	CHATTANOOGA	SPOKANE	MELBOURNE
BUFFALO	BALTIMORE, MD.	CHICAGO	MEMPHIS	PORTLAND, ORE.	TOKIO, OSAKA
PHILADELPHIA	CHARLOTTE, N. C.	PEORIA, ILL.	NEW ORLEANS	SEATTLE	BUENOS AIRES



This diagram shows a partial application of the Modutrol System as used to modulate the supply of fresh and warmed air from unit ventilators in a school installation. Master control supplied by Modutrol thermostat. Heat supplied by direct radiation elsewhere in building is automatically controlled by Modustat on each radiator.

The Modutrol System



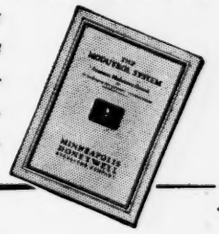
provides specialized automatic control for unit ventilators and air conditioning systems

In schools, public buildings, large buildings of all kinds where unit ventilators, or air conditioning systems are installed, the Minneapolis-Honeywell Modutrol System provides automatic *electrical modulation* control.

This is no rigid, arbitrary control system. On the contrary, it is flexible and easily engineered to meet exactly the special conditions surrounding each installation. Minneapolis-Honeywell engineers select the proper equipment needed for each of your jobs from a complete line of automatic controls. The result is an individual Modutrol System precisely engineered to give precision automatic modulating control.

For detailed description of the Modutrol System, write for your copy of the free Modutrol booklet. Further information about the interesting applications of this automatic control system will be supplied, without any obligation, by one of the Minneapolis-Honeywell engineers in your city.

Minneapolis-Honeywell Regulator Co. *Executive Offices:* 2715 Fourth Avenue So., Minneapolis, Minn. *Factories:* Minneapolis; Elkhart, and Wabash, Ind. *Factory Branches or Distributors in all principal cities. In Canada:* Minneapolis-Honeywell Regulator Co., Limited, Toronto and Montreal. *Export:* 801 Second Ave., New York City.



MINNEAPOLIS-HONEYWELL REGULATOR CO.
2715 Fourth Ave. So., Minneapolis, Minn.
Please send me your booklet, "The Modutrol System"

*Name*_____

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*Type of Building*_____

The Barber-Colman Electric System of Temperature Control

AN ACCURATE, GOOD-LOOKING THERMOSTAT

For use with three-wire, low-voltage temperature control equipment

HERE is an electric thermostat that is distinctive not only for its dependable and accurate control, but also for its good appearance. The softly brilliant moulded case and base enclose working parts which are designed to perform effectively the functions for which they are intended, and which are rust-proofed before assembly to assure long life and dependable service. A number of models of the Room Thermostat shown in the illustration are available, being made with or without the thermometer on the case, with or without special cover screws, with or without detents to meet special conditions, and with either internal or external adjustment. These thermostats will actuate the controlled equipment on a temperature variation at the thermostat of 1° or less above or below the set point. Other models of Barber-Colman Room Thermostats having the same characteristics of good looks and accurate control as the above are as follows: Two-Temperature Thermostats, Duplex Thermostats, and Compound Thermostats. Barber-Colman instruments may be used in connection with any type of heating, ventilating or air-conditioning systems, and also for individual units of heating or ventilating equipment. You will be surprised at the low prices at which these good-looking and dependable control instruments can be obtained.

A 48-page catalog describing the Barber-Colman Electric System of Temperature Control will be mailed upon request. Write for your copy today.

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In America's newest and finest buildings

TRACE the skyline of any metropolis and prominent among the many fine buildings you will find complete installations of "SPANG" WELDED STEEL PIPE—the product of one of America's oldest pipe manufacturers—the plant where century-old ideals of craftsmanship are combined with ultra-modern methods to produce America's outstanding quality pipe. "SPANG" WELDED STEEL PIPE is universally distributed, assuring quick availability whenever or wherever needed.

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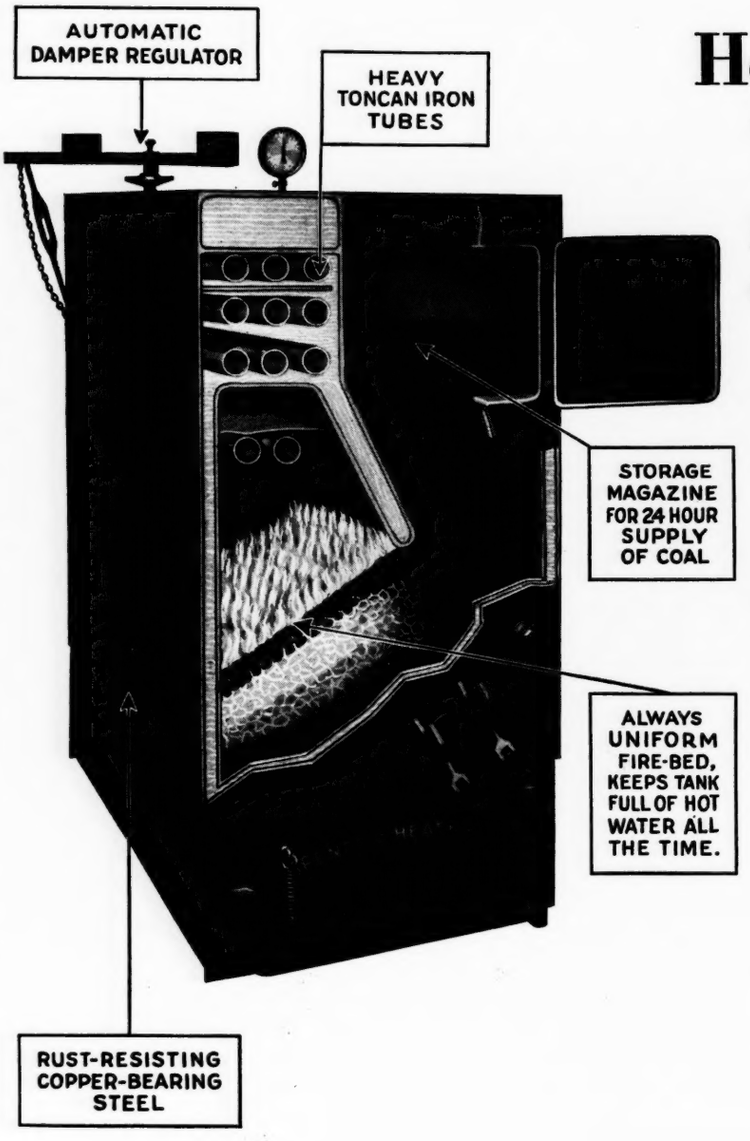
The Only Tank Heater
With All These Quality Features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RUST-RESISTING COPPER-BEARING STEEL

Spencer Heavy Duty Steel Tank Heater

For apartments and other large buildings

There is a definite demand, especially in the larger cities, for tank heaters to supply the hot water requirements of apartments, institutions, etc. The new Spencer Heavy Duty Steel Tank Heater supplies this demand by providing an advanced type of rugged construction and many advantages not found on any other tank heater.

Labor Saving

Fire burns 12 to 24 hours without attention.

Economical Operation

Uses low-cost No. 1 Buckwheat Anthracite or small size coke.

A Continuous Hot Water Producer

Built to withstand 125 lbs. working pressure. Outlasts several lighter built heaters.

Lifts You Out of Competition

Instead of offering "just another tank heater", you can increase your volume and profits by selling this improved Heavy Duty Steel Tank Heater. Write for descriptive literature.

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BOILERS
for steam, vapor or hot water

MEETING THE DEMAND FOR MODERN HEAT

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H.A.THRUSH CO., PERU
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Thrush System is better equipment from your point of view, Mr. Heating Contractor.

It is thoroughly safe, dependable, efficient and economical—the kind of equipment you can endorse with confidence.

Thrush System guarantees mild, even, healthful heat—automatically and conveniently in any climate. Thrush Equipment works equally well on old or new installations, and with any kind of fuel. The first cost of Thrush System is small; and maintenance is negligible, for Thrush is practically lifetime equipment.

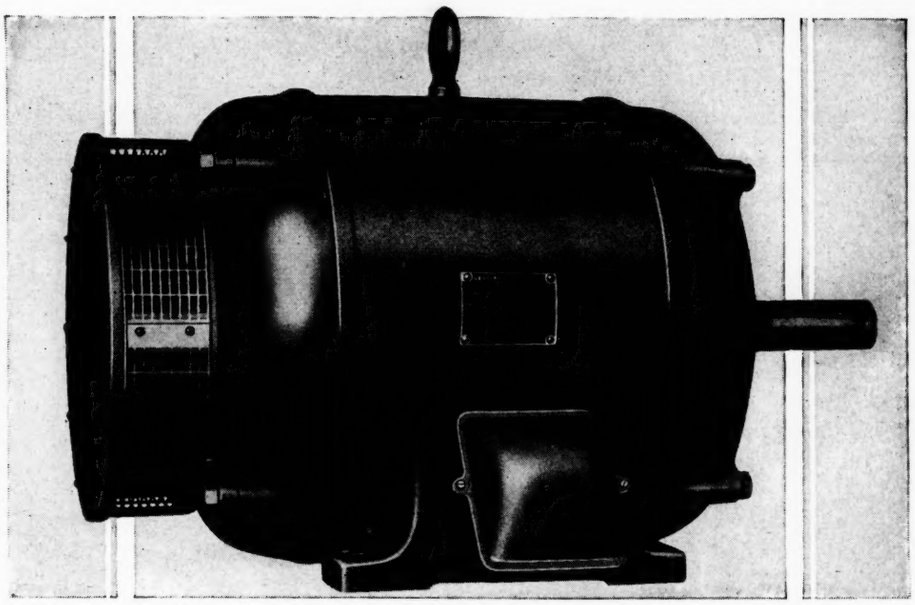
We will be glad to show you how Thrush System can make sales easier and build good will for you. Write us for complete information.

H.A.THRUSH & COMPANY

Pioneer Builders of Hot Water Heating Equipment

PERU, INDIANA

THEY KEEP A-RUNNING



10 Horse Power Century Type SC Multi-speed Constant Torque Squirrel Cage Induction 3 Phase Motor

Totally Enclosed Fan Cooled MULTI-SPEED MOTORS

Constant Horse Power — Constant Torque — Variable Torque

These Multi-speed Squirrel Cage Motors are especially suitable for operating fans, blowers, stokers and other equipment where adjustable speed requirements must be met. They are built in 2, 3 and 4 speeds, with wide or narrow speed ranges—such as 1800/1200 or 1800/600 down to 900/450 R.P.M. (60 cycle). Special speed combinations are also available.

Their Totally Enclosed Fan Cooled construction gives the added advantage of full protection to the windings, armature and other internal parts of the motor when operated in surroundings where dust, dirt, dampness and fumes are present in objectionable quantities. Operating continuity is thus assured in hard service applications.

Built in standard sizes up to 150 horse power in normal torque and normal or low starting current types.

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SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

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FOR MORE THAN 27 YEARS AT ST. LOUIS

TEMPERATURE control with unit heaters is usually accomplished by starting and stopping the fans. But is this method entirely satisfactory? Let's see.

When the fans are shut down, the positive delivery of heated air stops. However, a limited heating effect continues, due to the natural flow of air through the heaters. This heating effect keeps portions of the building adjacent to the heaters warm long after remote sections have cooled off. Thus, if the thermostat is located at the heaters, the fans seldom remain in operation sufficiently long to properly heat far corners; while if the thermostat is located a maximum distance from the heaters, sections of the building close to the heaters are likely to be overheated most of the time.

Balanced Heating is radically different. THE TEMPERATURE OF THE AIR DELIVERED IS CONTROLLED, AND THE FANS KEPT IN OPERATION CONTINUOUSLY DURING WORKING HOURS PROVIDING A POSITIVE CIRCULATION TO ALL PARTS OF THE BUILDING. Uniform heating is the result, with any desired temperature accurately maintained.

The method is simple, dependable, and not expensive. For full details on Clarage UNITHERM Balanced Heating Units, use the coupon below.

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CLARAGE FAN COMPANY, Kalamazoo, Michigan

Kindly send me full details on Clarage UNITHERM Balanced Heating Units.

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Much depends upon the metal . . . choose it carefully

WHEN the service life of costly ducts, risers and chambers is at stake, it pays to scrutinize the sheet metal. One replacement in an inaccessible spot can quickly wipe out any small initial saving that resulted from the use of an inferior metal.

But consider Armco sheets and plates for a moment. There are several different grades, from which you can select the metal that is sure to meet the conditions uncompromisingly. Each is produced with an eye to the intended application. And its cost is always compatible with its performance.

For installations where corrosion is not a serious factor, Armco steel sheets and plates will give a good measure of service. Where corrosion threatens, "Ingot Iron" is the wise choice. This is the refined iron that possesses the longest record of actual service of any low-cost, rust-resisting sheets and plates.

An experienced Armco Engineer is ready to help you determine which of our various grades will be most suitable for your purpose. Call him in, from the office nearest you.

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every Monday night
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ARMCO
IRON AND STEEL
SHEETS EXCEPTIONAL QUALITY PLATES

GOOD ENOUGH FOR THE *Waldorf!*

The Waldorf-Astoria—already a world-famous name—fast becoming a new land mark in Upper Manhattan's sky-line. Architects, Schultze & Weaver. Builders, Thompson & Starrett.

REARING its proud towers forty-seven magnificent stories above the street. A modern architectural triumph that recaptures the glamorous atmosphere of its famous thirteen-story predecessor. Only the finest, the most reliable, the most durable materials and equipment were worthy of becoming a part of the new Waldorf-Astoria.

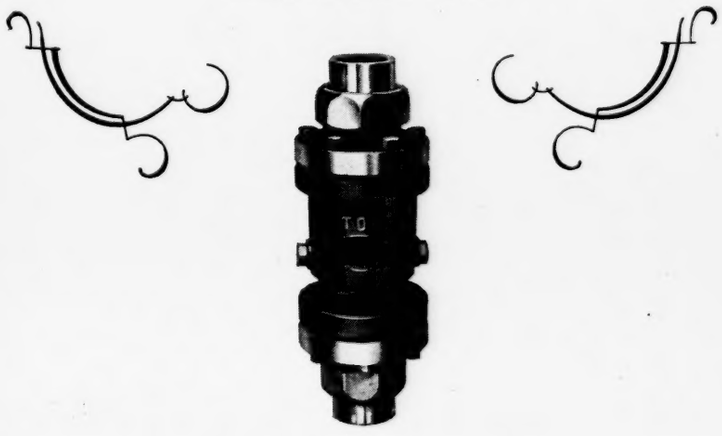
Naturally, Sylphon Packless Expansion Joints, over 800 of them, were selected for the miles of heating risers in this great structure.

The advantages of Sylphon Joints are many, definite, conclusive. For instance, as compared with bulky pipe bends requiring additional building height to permit concealing between floors — Sylphon Joints are installed in the side walls, require very little more space than ordinary pipe fittings, reduce non-revenue producing space to a minimum.

Also, because these Joints are packless, they are permanently leakless. They may be installed and forgotten, with confidence that they will not leak, will not necessitate frequent messy, expensive replastering and refinishing of large areas of water-damaged walls. They will not jam, will never need packing or other attention.

The list of prominent buildings in which these time-tested Sylphon Expansion Joints are in use, reads like a "who's who" among important office buildings, hotels, hospitals, institutions, and public structures.

Write for Bulletin XH-300. Sent free on request. A valuable treatise that should be in every architect's and engineer's files.



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TRADE MARK
PACKLESS
EXPANSION JOINTS

AMERICAN SHEETS

OUTSTANDING
Among All Others

THE NEW
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Graham, Anderson, Probst & White, Chicago
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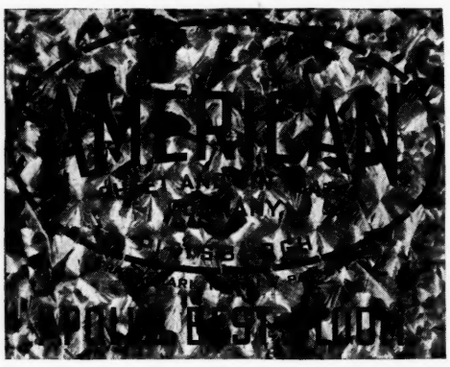
Distinctive among all of the surrounding structures both in appearance and usefulness to the community, this imposing structure is representative of the westward trend in modern building and is characterized by every detail of its construction being of the finest materials available.



In accordance with established quality standards, all steel sheets used in the ventilating system are

Apollo Best Bloom
Galvanized Sheets

Write for full information on AMERICAN Black and Galvanized Sheets, Special Sheets, Tin and Terne Plates, Keystone Rust Resisting Copper Steel Products, and U S S Stainless Steel Sheets.

AMERICAN SHEET AND TIN PLATE COMPANY, Frick Bldg., Pittsburgh, Pa.
SUBSIDIARY OF UNITED STATES STEEL CORPORATION

Let the Figures Speak for Themselves!

It is easy to talk big savings . . . difficult to prove them in many cases. But here is the exception: Fortunately, these twenty-two buildings, under Duo-Stat control, were all customers of a district heating company. The tabulation was therefore based on *meter* readings. Let the figures speak for themselves:

COMPARATIVE STEAM CONSUMPTION IN 22 BUILDINGS IN INDIANAPOLIS
BEFORE AND AFTER DUO-STAT CONTROLS WERE INSTALLED

Building	BEFORE DUO-STATS WERE INSTALLED Steam used 1929-30	AFTER DUO-STATS WERE INSTALLED Steam used 1930-31	Reduction	Percent of Reduction
Kahn Bldg.	3,587,000	3,236,000	351,000	10%
State Life	8,335,000	6,417,000	1,918,000	23%
Hook Whse.	7,119,000	6,047,000	1,072,000	15%
Fire Hdqtrs.	3,029,000	2,594,000	435,000	14%
Municipal Gar.	4,651,000	3,191,000	1,460,000	32%
Indpls.Water	1,143,000	970,000	173,000	15%
Blacherne	5,327,000	4,622,000	705,000	13%
Northern	2,917,000	2,325,000	592,000	20%
Times	2,649,000	2,168,000	481,000	18%
Civic Theater	942,000	866,000	76,000	8%
Lindley	281,000	206,000	75,000	27%
Priscilla	1,467,000	1,261,000	205,000	14%
Mayflower	2,021,000	1,633,000	388,000	19%
Wm.Penn (N)	2,215,000	1,504,000	710,000	32%
Wm.Penn (S)	1,897,000	1,560,000	336,000	18%
Dolly M.	3,956,000	3,511,000	445,000	11%
Murphy M.	1,093,000	878,000	214,000	20%
Hampton Ct.	10,320,000	7,139,000	3,181,000	31%
Bookwalter B.	6,199,000	5,077,000	1,122,000	18%
Medical Arts	6,509,000	4,032,000	2,477,000	38%
Perry Apts.	2,458,000	2,065,000	392,000	16%
Colonial Apts.	2,014,000	1,746,000	267,000	13%
TOTAL	80,129,000	63,048,000	17,081,000	21.3%

Total Steam Consumed during the Heating Season of 1929-30 — 80,129,000 lbs.

Total Steam Consumed during the Heating Season of 1930-31 — 63,048,000 lbs.

TOTAL REDUCTION — 17,081,000 lbs.

Per Cent of Saving — 21.3%

*The Actual Net Saving Was 22.4%

For anyone who might attribute this saving to a difference in the weather of the two seasons we have more documentary evidence —a comparison of the same two seasons for 15 other buildings not under Duo-Stat control. This comparison, also based on meter readings, shows an *increase* of 1.1% in 1930-31 as compared with 1929-30. Using this as a correcting figure the saving, shown on the face of the figures opposite, actually becomes 22.4%!

Space does not permit publishing this tabulation, but we will gladly mail it to you.

The total cost of the 22 installations was less than the cost of the steam saved during the 1930-31* heating season.

F. I. RAYMOND CO., 629 W. Washington Blvd., Chicago, Ill.

YOU'LL see this seal on the letters of progressive manufacturers whose products will stand thorough examination by the keenest, most progressive buyers.

DOUBLY IMPORTANT

AN exposition which brings to alert manufacturers the greatest number of potential buyers in the shortest space of time at a minimum expense.

The seller exhibits, explains, demonstrates.
The buyer looks, listens, and chooses.

Both are free from the distractions of their daily work.
They give their undivided attention to the product displayed.

Progressive manufacturers and buyers will make the most of this opportunity.

Buyer and Seller both profit. Will you?

AN INTERNATIONAL EVENT HELD EVERY TWO YEARS

Under the auspices of the American Society of Heating & Ventilating Engineers
Managed by the International Exposition Company

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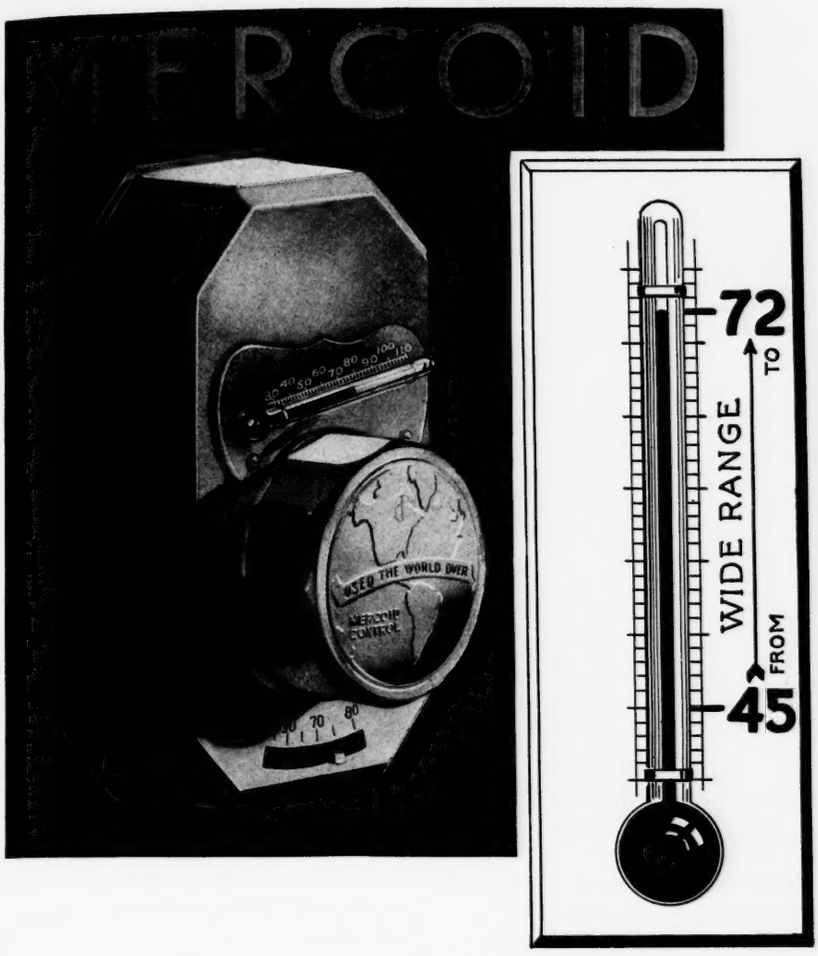


A NEW WIDE RANGE TEMPERATURE CONTROL FOR ALL TYPES OF UNIT HEATER APPLICATIONS

This new Mercoid wide range Thermostat is designed to operate within the range of 45 to 72 degrees F., and maintains extreme accuracy over any setting within this range.

This instrument simplifies unit heater control installations. The same Thermostat may be applied on practically all unit heater requirements in garages, factories and other buildings, in which both low and normal room temperatures are desired.

It is necessary to carry only one model in stock, which will take care of almost any type of job.

Mercoid Automatic Controls comprise a complete line of highly developed instruments which are used with unit heaters, oil burners, stokers, gas burners, refrigeration equipment and various industrial applications.

All Mercoid Controls are equipped with the latest developments in sealed mercury contact switches. They are not affected by dust or corrosive gases. There is no open arcing or oxidation.

These switches will operate indefinitely under all industrial conditions.

The Mercoid engineering department will gladly co-operate on all control problems.

A catalog showing Mercoid standard controls will be sent upon request.

THE MERCOID CORPORATION

Sole Manufacturers of The Mercoid Switch

4201 BELMONT AVENUE, CHICAGO, ILLINOIS

MERCOID AUTOMATIC CONTROLS

FIG. M-53 FURNACE FAN CONTROL

Used for all furnace fan applications. Fully protected through license under patent reissue 15,531.

Type S M I PYRATHERM

A complete oil burner stack safety control with ignition cut-off to guard against flame or ignition failure.

MERCOID TYPE TU

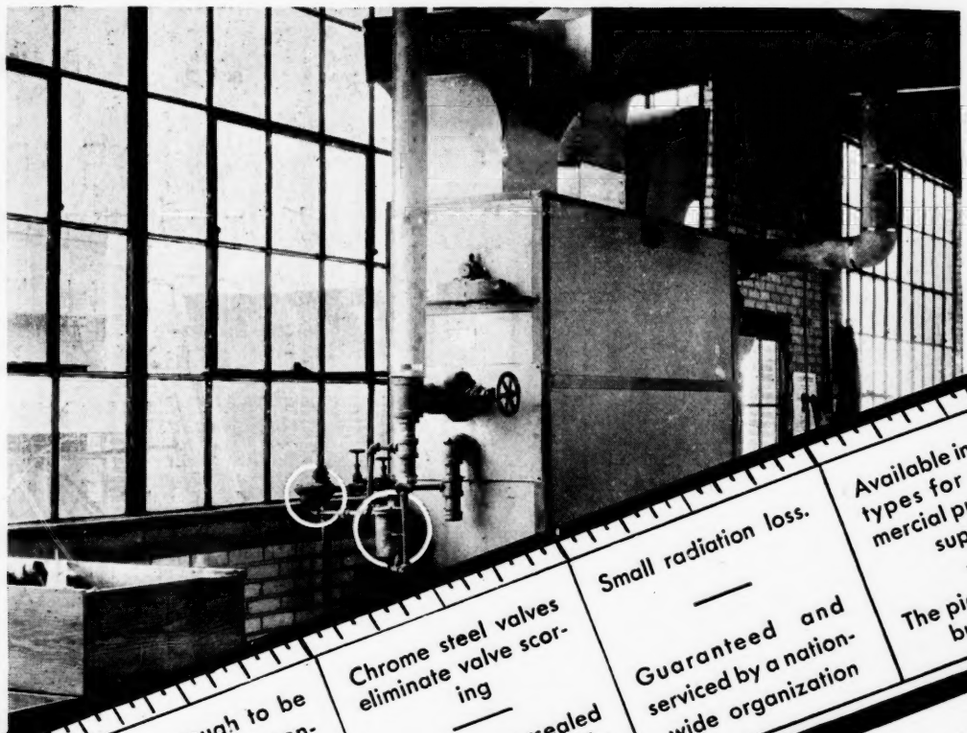
Constant Current Incandescent Ignition and Control System for Liquid Fuel Burners. Eliminates radio-interference.

FIG. 31 PRESSURE CONTROL

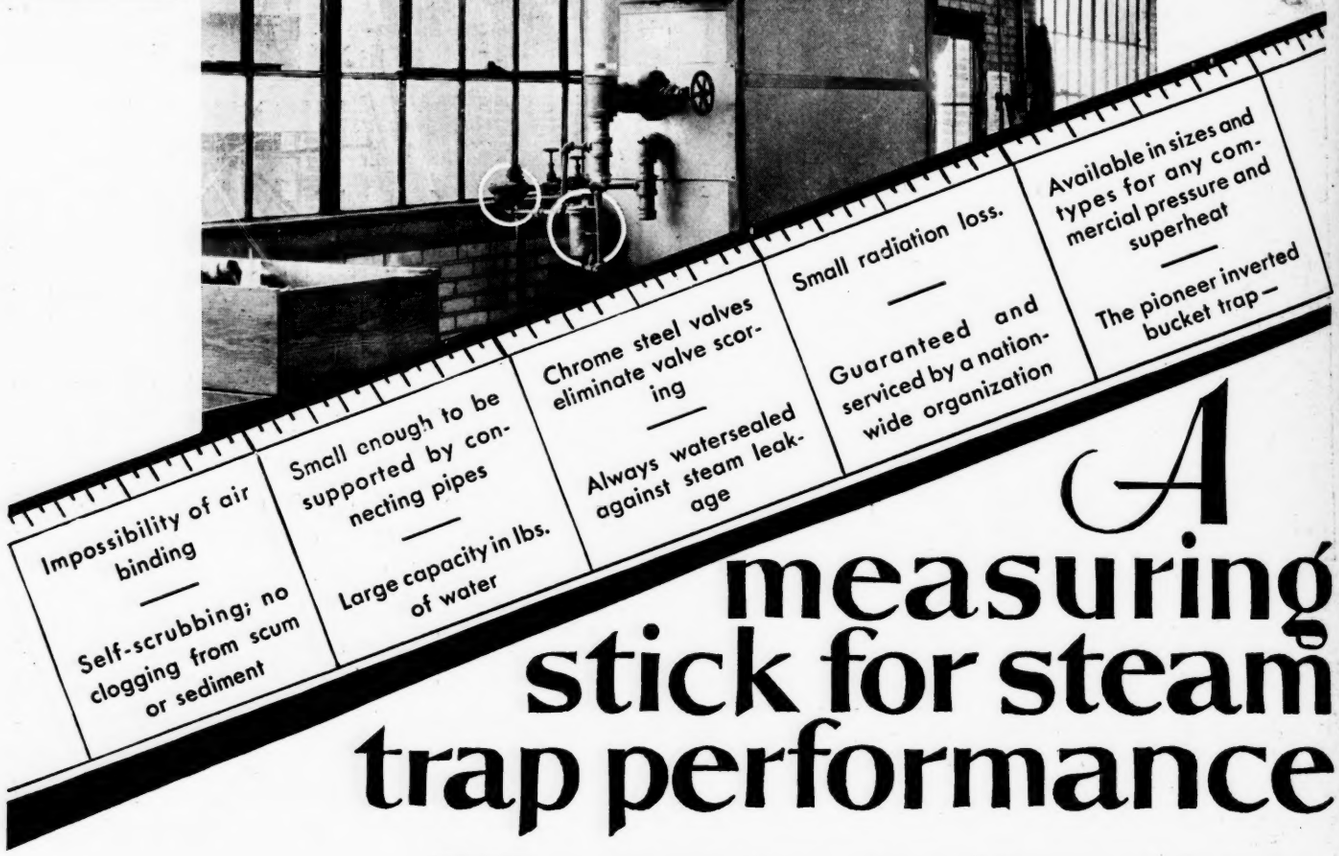
A positive safety limiting device employed as a steam boiler control or with any pressure medium not injurious to bronze or steel.

FIG. 71 LOW WATER AND PRESSURE CONTROL

Prevents firing into dry boilers or building up excess pressure; also furnished as low water cut-out only.



Armstrong Traps draining steam header and York unit heater


Impossibility of air binding
Self-scrubbing; no clogging from scum or sediment
Small enough to be supported by connecting pipes
Large capacity in lbs. of water
Chrome steel valves eliminate valve scoring
Always watersealed against steam leakage
Small radiation loss.
Guaranteed and serviced by a nation-wide organization
Available in sizes and types for any commercial pressure and superheat
The pioneer inverted bucket trap—

A measuring stick for steam trap performance

THE accompanying "measuring stick" represents features of the Armstrong Inverted Bucket steam trap. No other trap has *all* these features, which helps to explain why there are more Armstrongs in use than any other mechanically operated trap.

With Armstrongs installed on unit heaters, the manufacturer can insure satisfactory condensate drainage *on the job* like he controls workmanship and materials during production. The unit heater does not get a "black eye" because of air binding and faulty condensate elimination which are not faults of the unit heater itself.

We are glad to cooperate with heating contractors and engineers in determining the proper layouts and trap sizes on heating jobs, without obligation. Booklet giving trapping data sent on request.

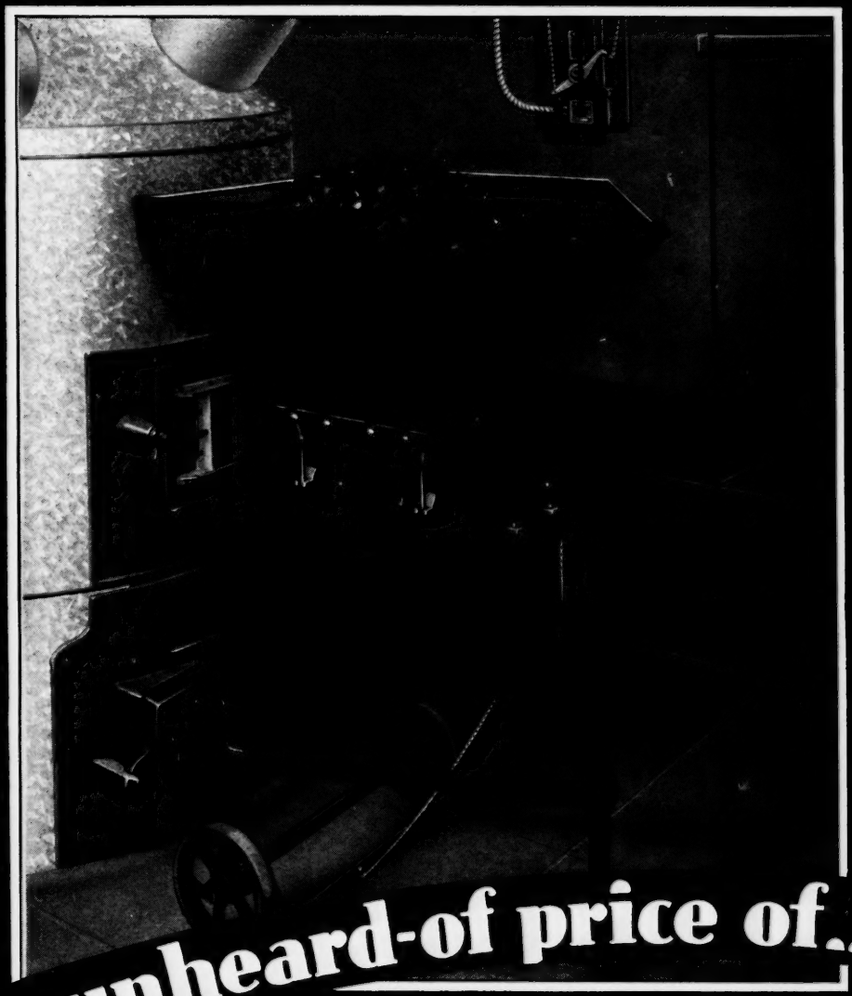
ARMSTRONG MACHINE WORKS

846 Maple Street :: Three Rivers, Mich.

H&V 12 Gray

Announcing the New

CROSLEY AUTOSTOK



for STEAM
HOT WATER
VAPOR *and*
WARM AIR
FURNACES

Retails at the unheard-of price of..

$175.00

CROSLEY AUTOSTOK

Lowest in first cost . . .

Sells for half or less than the cost of other electrically operated stokers. Fully automatic and thermostatically controlled.

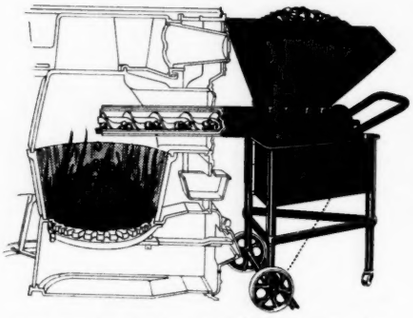
Readily salable . . .

Attracting that vast market of medium-priced homes where the average wage earner is interested in saving labor, health, money and adding comfort to his home.

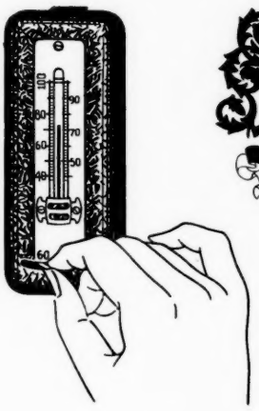
Note these outstanding features . . .

1. Installation time—Less than 2 hours for one man.
2. Can be used on boilers and furnaces with fire-pot as small as 12½ inches diameter up to 34 inches diameter inside measurements.
3. Capacity—200 pounds of hard coal or 140 pounds of coke in one filling.
4. Feeds common soft coal (no slack) semi-bituminous, smokeless or Pocahontas, anthracite or small coke.
5. Three feeding speeds care for various sizes of fire boxes—easy to adjust.
6. Maximum delivery of coal per hour is 40 pounds. Rate of delivery varies with different fuels used.
7. Approximate heating capacity—1400 square feet water radiation or 850 square feet steam radiation.
8. No noise or vibration.
9. Automatic safety control eliminating danger of damage to gears or motor should the feed screw become clogged.
10. Secondary air transmitted through a chamber around the four-inch feed pipe, cooling the feed screw and avoiding the possibility of burning it and permitting proper breathing of the fire.
11. Driving mechanism is simple, compact, trouble-proof, and rugged. Only six moving parts.
12. No return of smoke through hopper.
13. Standard equipment consists of:
    a. Stoker
    b. Control Panel
    c. Thermostat
    d. Extension Cord
    e. 30 ft. of Draft Chain
    f. 4 Draft Chain Pulleys
    g. 75 ft. of Thermostat Wire
14. Operated by 1/6 horse power motor and attractively finished in red and black enamel with cadmium plated wheels.
15. Low cost to purchase, low cost to operate.
16. Practically a smokeless operation.
17. Automatic temperature control.

You easily wheel the Crosley Autostok from coal bin to fire. No coal to carry—no dirt—dust.



Cross sectional view showing the Crosley Autostok in operation. Note how Autostok maintains a scientifically correct conical fire.



Maintain the desired temperature by merely setting the indicator at the degree of warmth wanted.

Get in touch with the distributor of Crosley Products in your territory. If you don't know him, write or wire direct . .

THE CROSLEY RADIO CORPORATION

Powel Crosley, Jr., ***President*** **CINCINNATI** **Home of** ***"the Nation's Station"*****—WLW**

SPECIAL OFFER TO RETAIL DEALERS

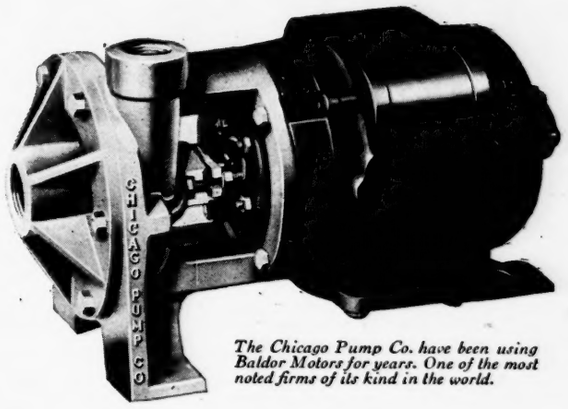
So that you may have a Crosley Autostok in your own home where you can demonstrate it to your customers, all Crosley distributors are cooperating with the factory in offering you (for low price of $113.75 f. o. b. your city. In the West the special price is $122.20. This offer is not extended to the consumer, and is good only until January 1, 1932. Pin this coupon to your

Another list of national firms who have used Baldor Motors from 1 to 10 years.

General Fire Ext. Co.
Auburn, R. I.
General Heating Spec. Co.
Kansas City, Mo.
Gerard Electric Co.
Boston, Mass.
J. E. Gilbert Grinder Co.
Milwaukee, Wis.
Grinnell Co.
Providence, R. I.
O. E. Hadwiger
Pueblo, Colo.
Handy Sack Baler Co.
Marion, Iowa
Hayes Pump & Machine Co.
Boston, Mass.
Herzler & Henninger
Belleville, Ill.
Heston & Anderson
Fairfield, Iowa
Home Electric Light & Power Equip. Co.
Boston, Mass.
Howe Ice Machine Co.
Chicago, Ill.
Hyre Electric Co.
Chicago, Ill.
Ideal Heating Co.
Baltimore, Md.
Illinois Creamery Supply Co., Inc.
Chicago, Ill.
Illinois Elec. Vent. Co.
Chicago, Ill.
Illinois Oil Co.
Rock Island, Ill.
Industrial Air Filter & Pump Mfg. Co.
Chicago, Ill.
N. B. Johnson
Winthrop, Mass.
Johnson Fan & Blower
Chicago, Ill.
Kimble Electric Co.
Chicago, Ill.
King Co.
Owatonna, Minn.
Kosek Electric Co.
Cedar Rapids, Iowa
Henry Kuehnel
Elmhurst, L. I., N. Y.
G. P. Labberton
Yakima, Wash.
Ladewig Soelch Co.
Waukesha, Wis.
Lammert & Mann Co.
Chicago, Ill.
Lansing Supply Co.
Lansing, Mich.
LaSalle Automatic Oil Burner Corp.
Chicago, Ill.
Le Bron Electric Works
Omaha, Neb.
Lees-Cole Electric Co.
Sioux City, Iowa
Lehmann Machine Co.
St. Louis, Mo.

Specialists in Specialty Motors

Being a specialty motor business primarily, Baldor is set up to render far quicker and better service in developing original models as well as in actual production.



The Chicago Pump Co. have been using Baldor Motors for years. One of the most noted firms of its kind in the world.

Tested Baldor Motors up to 103 degrees centigrade, and they ran as good as ever after cooling ~ ~ ~

That drastic test is like hanging a man to see how strong his neck is. But the fact remains, Baldors *came through.* Many other motors would be shot to pieces on such a test. In one test after another, as well as in years of actual use, Baldors keep on piling up the evidence that they are built like the Rock of Gibraltar.

Why not get some of this evidence before you buy motors next time?

Baldor Electric Co., 4356 E. Duncan Ave., St. Louis, Mo.

BALDOR

A BETTER MOTOR

BACK

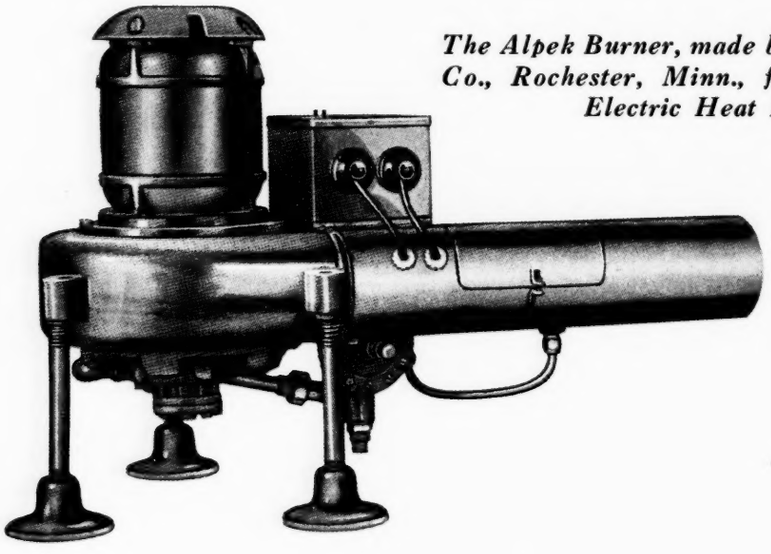
OF THIS PRODUCT

BACK of the General Electric Heat Regulator are the resources, the research facilities, and the production experience of General Electric. This means a product in which both *you* and *your customers* can have complete confidence.

Back of it also is the most extensive advertising campaign ever given a product of this kind . . . a campaign stressing the exclusive features of the G-E Heat Regulator, which make it possible to control temperature with not more than ½ of 1 degree variation!

These features include such things as: a thermostat which *anticipates* rises in room-temperature and prevents overshooting, or dropping 'way below, the temperature selected . . . close differential thermostat . . . silver-nap action-contacts . . . rugged construction . . . D. C. no-hum coils. All of these things insure greater customer-satisfaction, and less servicing after installation.

You can easily profit by the interest being aroused in this new G-E product. Equip your oil-burners with it; or ask your manufacturer to do so. More than 50 per cent of all oil-burners now manufactured are furnished to dealers with General Electric Heat Regulators as standard or optional equipment. For complete information, address: Penn Heat Control Company, *National Distributors,* Franklin Trust Building, Philadelphia, Pa.



The Alpek Burner, made by Heating Specialties Co., Rochester, Minn., features the General Electric Heat Regulator

GENERAL ELECTRIC

HEAT REGULATOR

FOR EVERY TYPE OF HEATING SYSTEM

To sell more oil burners

You need a complete line *but* all under one brand, one policy... Here's why.

The Metropolitan Tower, Riverside Church, Holland Plaza Building, typical home and oil truck shown here, symbolize Petro-Nokol oil heat being enjoyed by more than 550,000 from coast to coast.

Sell three *different* brands of burners... and you live in a house divided against itself. One says, do this... the other says no! Policies clash. Favor one and displease the other two. What chance of 100% co-operation? How can any one of three manufacturers give you all he has for you... when you are giving him but a fraction of your support?

Yet a complete line of equipment is vital to success. For one-fourth of your market is calling for a rotary. Another sixth can best be served with a heavy fuel oil domestic burner. Fully a third of your business can come from sales of a pressure type with electric ignition and pump. And big jobs represent a very happy one-quarter of your volume.

Petroleum Heat & Power Company is the only manufacturer offering a specific burner for every heating need. Under one brand, one policy, one program. As a nation-wide public service enterprise, we have demonstrated that different types and sizes of heating plants require different types and sizes of burners.

Under this unified leadership, Petro-Nokol dealers have shown a remarkable increase this year over last. Yet their inventory stocks are as small as many dealers selling only one type of burner. Our method of operation solves that problem.

In addition to the only complete line... they have all the price advantages of the $295 Rotary. The priceless sales help and guidance of outstanding merchandisers. The most effective newspaper advertising campaign in the industry. And, the tremendous advantage of representing the oldest and largest oil heating organization in the world.

It will pay you to discuss this matter further with one of our representatives, or to write direct to the factory.

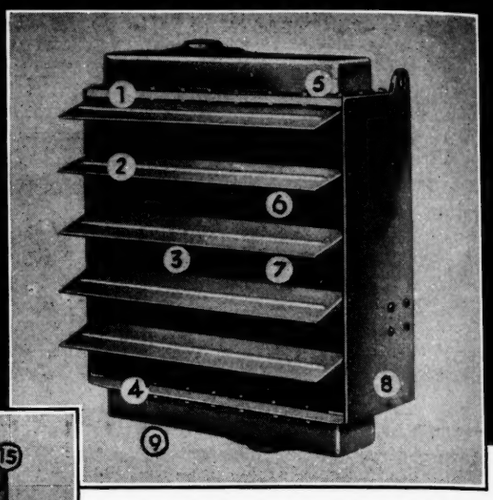
PETRO-NOKOL

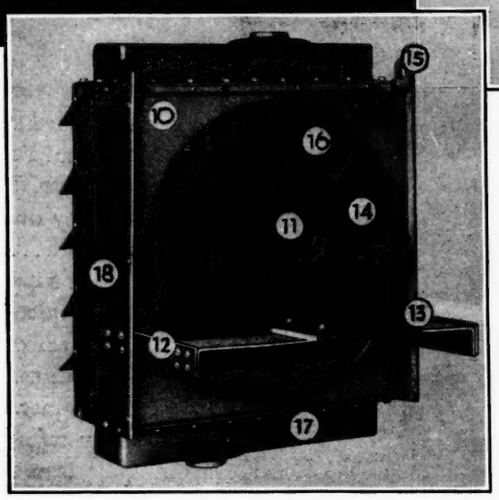
PETROLEUM HEAT & POWER CO.

World's oldest and largest oil heating organization

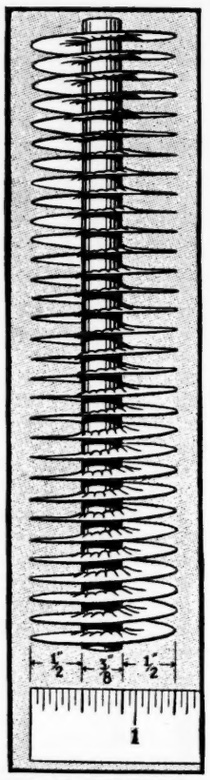
Main Offices and Plants: Stamford, Conn.

McCORD *Announces* a New Line of Better-Built UNIT HEATERS





1. Extra heavy header plates.
2. Adjustable louvers
3. Individual spiral fin tubes—removable for inspection or replacement.
4-5. Tanks are bolted to header plates, removable for cleaning.
6. Tubes are scientifically spaced, result: air resistance low.
7. Extra wide fins tightly joined to tubes by special tinning process—better heat conductivity.
8. Attractive green lacquer finish.
9. Entire unit heavily tinned inside and out. Tested for 125 pounds working steam pressure.
10. Scientific design of fan shroud makes for efficiency.
11. Fan removable without disturbing motor.
12-13. Two point motor support—no strain on radiator tanks.
14. Standard makes of unit heater motors supplied.
15. Balanced suspension—no strain on steam pipes.
16. Extremely quiet balanced fan.
17. Clean cut appearance.
18. Heavy side plates support motor and fan independent of radiator.



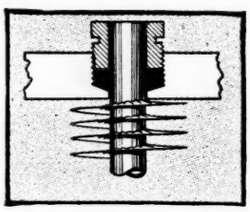
SPIRAL FIN TUBING

McCord pioneered the development and manufacture of spiral fin tubing for unit heaters and has supplied leading unit heater manufacturers with it for many years. The first light-weight unit heater introduced commercially used spiral fin tubing manufactured by McCord. For 25 years McCord has been a pioneer and a leader in the science of heat transfer, being noted for its many outstanding accomplishments in designing and manufacturing automotive radiators, refrigeration condensers and evaporators.

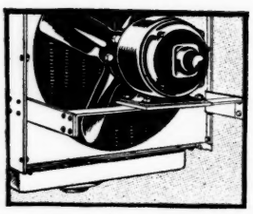
Now, after two years of engineering research, McCord announces its own Unit Heater which sets a new standard in accessibility and convenience. It features a newly-developed copper fin that is twice the width commonly used. This increase in fin surface balances the ratio between it and the tube surface, permitting a tube spacing that reduces resistance and allows a better air flow.

Manufacturers' agents are invited to write for full details and prices. There are a number of excellent territories open for established representatives who can furnish proof of desirable contacts.

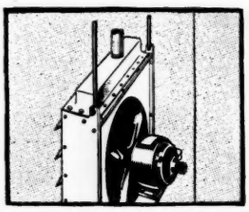
UNIT HEATER DEPARTMENT



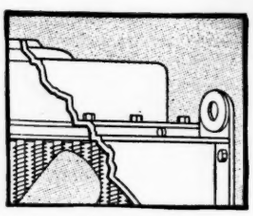
COMPRESSION NUT MAKES TIGHT JOINT



TWO POINT MOTOR SUSPENSION



BALANCED SUSPENSION



HEAVY TANKS

McCORD
RADIATOR & MFG. CO.—DETROIT, MICH

Manufacturer of Automotive Radiators and Gaskets, Mechanical Lubricators, Easy-Out All-Metal Ice Trays.

ILLINOIS HEATING SYSTEMS

FISHER BUILDING, Detroit, above; NEW CENTER BUILDING, at right. Albert Kahn, Inc., Architects, Johnson, Larsen & Co., Heating Contractors, for both buildings.

—another Repeat Order

After observing the performance of an ILLINOIS Heating System in the famous Fisher Building, ILLINOIS was again chosen for the New Center Building, newest of this notable group of Detroit Buildings.

ILLINOIS Thermo Radiator Traps have the longest record for successful use of any Trap now on the market. Specifying ILLINOIS Heating Equipment gives unified responsibility and positive guarantees.

WRITE FOR BULLETIN 22

ILLINOIS ENGINEERING COMPANY

ROBT. L. GIFFORD. PRES. INCORPORATED 1900

BRANCHES AND REPRESENTATIVES IN 40 CITIES

CHICAGO

CLASSIFIED ADVERTISING

Advertisements under this heading, $2 per inch, payable in advance. A 1-in. advertisement contains about 35 words in this size type. Larger type and spacing at $2.00 per inch. To secure insertion copy must be received not later than the 20th of the month preceding date of issue.

HEATING AND VENTILATING—148 Lafayette Street, New York, N. Y.

NEW AIR CONDITIONING

Is spreading like wild fire. The public in general are asking about it—people want to know how it will serve them in comfort, satisfaction, and to be in style with the Jones's, etc.

Can You Answer Their Questions Fully?

The INSTITUTE has specialized Air Conditioning Courses, for Forced Warm Air Plants, Steam and Water Plants, large Mechanical systems. It is the ideal thing for Shop Owners, their Sons, Partners, and all other tradesmen to prepare NOW to be good Salesmen later. Please indicate your desires:

Home Study Instruction
Private Class Instruction

This will be our 22nd year, Training Tradesmen, like yourself. Full information is free; check your course, write today. Get in line for Fall business recovery.

- ☐ **Heating, Ventilating and Refrigeration Engineering.**
- ☐ **Special Warm Air and Forced Air Heating**
- ☐ **Steam and Hot Water Heating**
- ☐ **Air Conditioning for Fan H. and Eng.**
- ☐ **Plumbing and Sanitary Engineering**
- ☐ **Contracting and Estimating**

The St. Louis Technical Institute
4543 Clayton Ave. ST. LOUIS, MO.

COMPANY FOR SALE

OTHER INTERESTS MAKE NECESSARY, SALE OF A COMPANY MANUFACTURING EQUIPMENT WHICH IS SOLD TO THE HEATING AND VENTILATING TRADE WITH EXCEPTIONALLY BRIGHT PROSPECTS. BOX NO. 177, HEATING AND VENTILATING, 148 LAFAYETTE ST., NEW YORK CITY.

WANTED: A SALES MANAGER to handle Unit Heaters, Concealed Radiation, Blast Cores and similar equipment. Must have experience and proven ability and general engineering knowledge of problem. Write fully education, experience and salary desired. Good opportunity to right man.

Address Box No. 178, care HEATING AND VENTILATING, 148 Lafayette St., New York.

The New York Blower Company requires successful and experienced fan and unit heater salesmen. For further information address The Sales Manager, 3155 Shields Avenue, Chicago, Ill.

HEATING and VENTILATING CLASSIFIED ADVERTISING

is especially recommended for the attention of the manufacturers in the industry who are desirous of meeting men of proven calibre and experience in their field.

ENGINEERS!

Now you can estimate fuel bills for every month in practically any locality in the U. S.

Get YOUR copy of The DEGREE-DAY HANDBOOK today!

56 pages—5½ x 7½ inches
3 folding charts—22 maps
PRICE $1.50

SYNOPSIS OF HANDBOOK CONTENTS

DEFINITION OF DEGREE-DAY—What the unit is, what it means, how it originated; why the base 65° F. is used instead of some other figure; how much fuel—either oil, gas or coal—is required per square foot of radiation, and how to correct these figures for other conditions. This chapter also explains how the degree-day tables were calculated.

THE COAL CHART, GAS CHART AND OIL CHART—Three charts are included by means of which the fuel consumption can be determined per square foot of either steam or water radiation per degree-day for various efficiencies, heat content of fuel, design temperatures, etc. This new material was especially designed for the handbook.

DEGREE-DAY TABLES—The number of degree-days for each month in 1000 cities in the United States. While the total number of degree-days for these cities have been published, *Never Before Have The Monthly Totals Been Available.* By means of these figures the engineer can estimate the fuel bill for every month for practically any locality in the country.

DEGREE-DAY MAPS, BY STATES—Maps of all the States, either by small groups or by single states, showing the lines of equal degree-days. These enable the engineer to determine the degree-day load in territories adjacent to those for which the exact load is given in the tables.

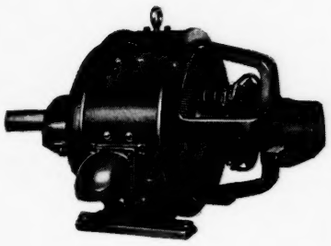
HEATING AND VENTILATING DEGREE-DAY MAP—The national map showing the lines of equal degree-days throughout the country.

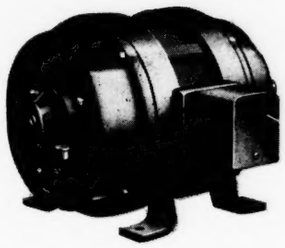
THE INDUSTRIAL DEGREE-DAY—Definition and tables of a new unit calculated on a lower temperature base than the standard degree-day for purposes of calculating fuel requirements of industrial plants which maintain an inside temperature lower than 70°.

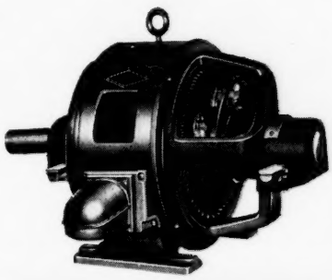
THE INDUSTRIAL DEGREE-DAY MAP OF U. S. A.—Gives you all the figures you want at a glance.

Your order will receive prompt attention, and the HANDBOOK will be sent prepaid by

Heating and Ventilating Book Service
140-148 Lafayette Street, New York City







QUIET OPERATION—

An outstanding characteristic of

IMPERIAL ALL STEEL MOTORS

The Imperial Electric Company have perfected a motor that is practically noiseless without in any way impairing its may other desirable characteristics. Pioneers in the introduction of quiet operation, their latest type motors represent the crowning achievement of years of engineering development and design.

Write to-day for details of the complete line, or any particular application that you want a motor applied to.

Specialists in building motors for every kind of application

—ASK OUR USERS—

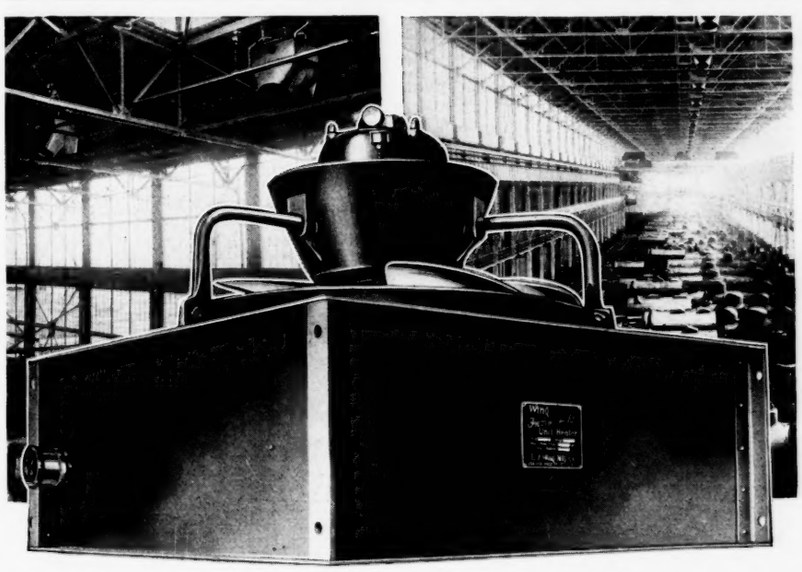
QUALITY SERVICE Imperial RIGHT PRICES COURTEOUS TREATMENT

THE IMPERIAL ELECTRIC COMPANY

AKRON, OHIO

BRANCHES IN ALL PRINCIPAL CITIES

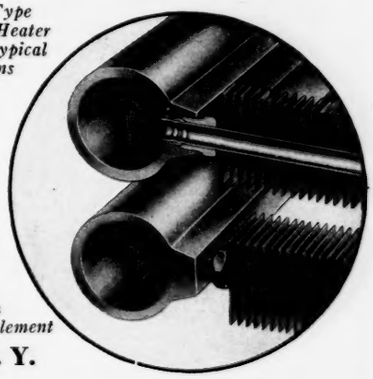
THERE *IS* A DIFFERENCE IN UNIT HEATERS



WING Design is exclusive with WING Featherweight Unit Heaters

The features of Wing Design are (1) light weight, (2) the vertical downward discharge of the heated air, and (3) multiple discharge outlets.

At left—Type HC Wing Heater and two typical installations



Detail of Wing Featherfin Heating Element

THESE exclusive Wing features are directly responsible for the great economies possible in industrial plant heating by the use of Wing Featherweight Unit Heaters.

Wing economies and advantages may be summarized as follows:

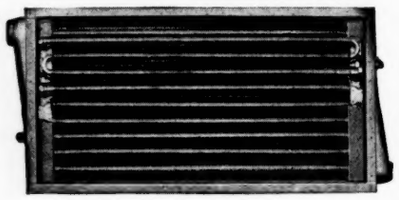
Economy of Steam ***Comfort*** ***Low Installation Cost***
Space Conservation ***Low Cost of Equipment*** ***Low Maintenance Cost***

Write for a copy of our complete catalog, explaining these points in detail.

L. J. WING MFG. CO., 158 W. 14th St., NEW YORK, N. Y.

Specialists in the design and manufacture of air-handling equipment since 1878

UNIT HEATERS, FOG ELIMINATORS, EXHAUSTERS, TURBINE BLOWERS, MOTOR DRIVEN BLOWERS, SAFETY VENTILATING FANS, MAN COOLERS



The Standardized Light-Weight Fan System Heat-Surface

Pressures up to 350 lbs. gauge

Unit illustrated in section is UNIVERSAL AEROFIN, *2½ to 200 lbs.*

Complete information upon request to Newark★

Any Office will gladly render prompt, efficient, technical cooperation

In the World's outstanding Structures,– in the most modern Heating, Ventilating and Air Conditioning Installations

AEROFIN
is the Heat-Surface

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AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus.

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PIPE FITTINGS

When Specifying Pipe Fittings for any job, whether it be large or small, care must be taken to secure a line that will assure a first class job with a minimum of labor expense.

This can be assured by specifying NM Fittings, known for their Clean Threadway, Straight Tapping and the Absence of Sand Holes.

Trade Mark Registered

ILLINOIS MALLEABLE IRON CO.

CHICAGO, ILLINOIS

NM

U. S. Patent Office 1912

No More Time Lost With
Dull Drills and Misfit Holes

Use Phillips Self-Drilling Expansion Shells for Fastening Pipe Hangers, Brackets and Other Equipment to Concrete Walls, Floors and Ceilings.

EVERY SHELL DRILLS ITS OWN HOLE
EVERY HOLE A PERFECT FIT

Made in types and sizes for all requirements. Quickly installed by hand or with Phillips Spring Hammer. Suitable Chucks and Holders furnished for installing with Pneumatic or Electric Hammers.

Drill Hole—Expand Shell—Remove Holder

A NEW SHARP-DRILL FOR EVERY HOLE

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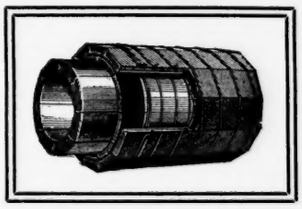
Pacific Coast Warehouse and Office
717 Calmar Ave., Oakland, Calif.

WYCKOFF'S
New Improved
Pipe Covering
SAFE--LASTING
ECONOMICAL



The New Improved Wyckoff Pipe Covering should be investigated before you specify insulation for either overhead or underground steam pipe installation. Made of a perfect non-conductor, cypress wood, it will increase the efficiency of any heating system and last a lifetime. *Write for our complete booklet on insulation this new way.*

We also manufacture wood water pipe for water supply lines and for carrying acids, gases in chemical paper plants, tanneries, sulphur water in mines, etc., for pressures up to 172 lbs. per square inch.

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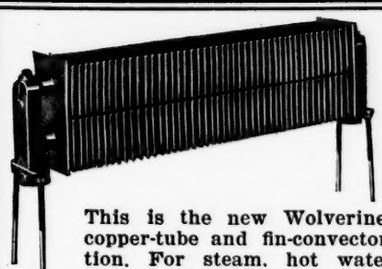
1855 ELMIRA, NEW YORK 1931



Wolverine Copper Tube Radiation

This is the new Wolverine design all-copper-tube and fin-convector type radiation. For steam, hot water or vapor. Sizes to fit all standard recess boxes.

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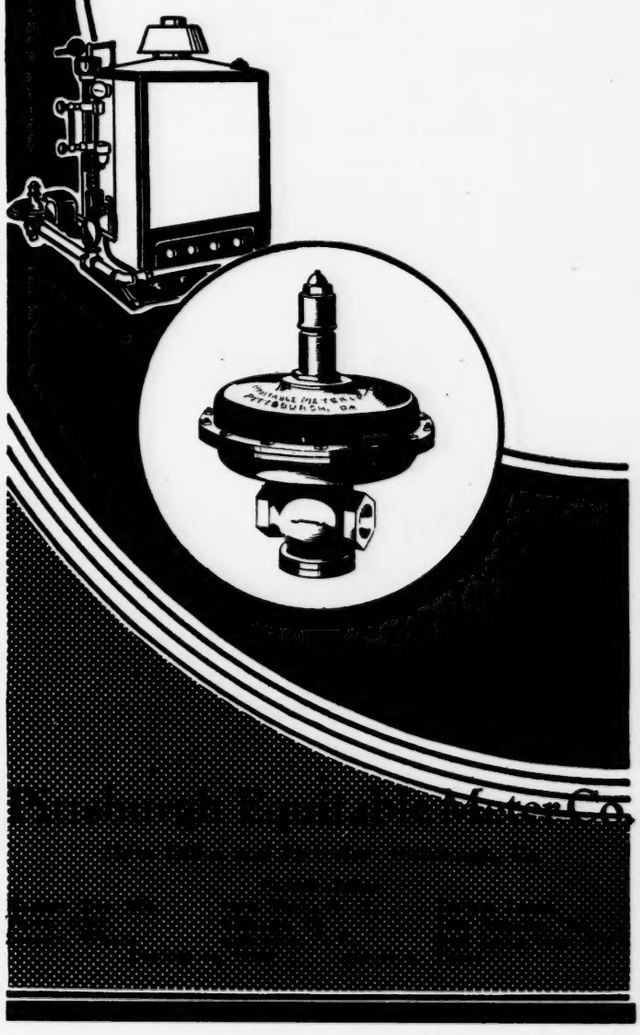
Constant pressure maintained by EMCO Gas Appliance Regulators goes a long way toward making perfect heating conditions and satisfied customers.



United States Ozone Company of America

(Business Established 1910)
SCOTTDALE, PENNA.

Trade Mark

Reg. U. S. Pat. Office

Ozone and Electrolytic Water Sterilizers
Ozone Air Conditioning Equipment
Industrial Ozonizers

We shall be glad to send you Complete Information and Engineering Data.

This Company Controls Exclusively United States Ozone Company Pennsylvania Charter 1920

We are splendidly equipped to supply all types of finned tubing for copper radiation.

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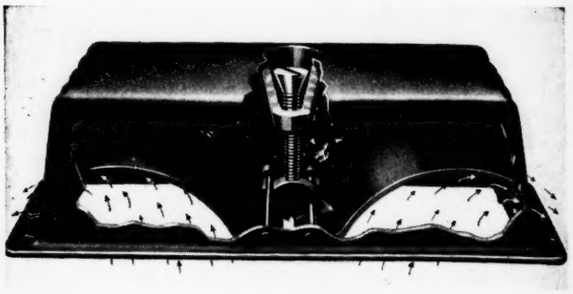
THE G & O MANUFACTURING CO.
New Haven, Conn.
Established 1915
Manufacturers of the famous "G & O" Radiators for automotive vehicles



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—assure proper ventilation

Enflo Diffusers possess a number of outstanding features that have earned nation-wide recognition from leading architects and ventilating engineers. In schools, auditoriums and theatres—wherever efficient air diffusion is required—Enflo will supply it with unsurpassed thoroughness, facility and economy.

Enflo eliminates drafts by diffusing air along the floor line, parallel to rows of seats. Both dampers are controlled by a single concealed screw, and the entire diffuser is of cast-iron construction, insuring long service.

Install Enflos—for your audience's comfort—and your economy. All details on request.

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STEEL BOILERS

For Big or Small Buildings—For Coal (Hand or Stoker Fired), Oil or Gas

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Patterson
Hot Water Heaters

In Chicago, too, Patterson Hot Water Heaters will be found in most of the super-structures.

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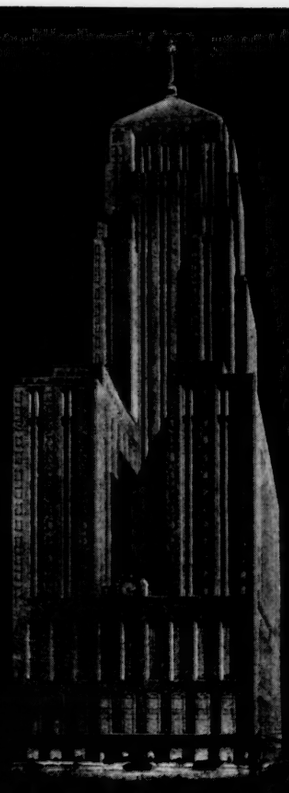

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VENTILATING FANS
(AIRPLANE PROPELLER TYPE)

MORE AIR... LESS POWER... LESS COST...

The CHARAVAY Patented overlapping propeller feature assures 25% to 50% more air per ring area and power consumed. There is a CHARAVAY for every ventilating requirement. Write or wire us for details.

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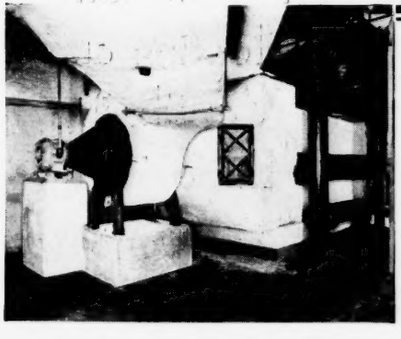
Division of Hartzell Industries, Inc. Established 50 Years



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increases sales and profits

Uniform atmospheric conditions throughout the year reduce spoilage and rejects, stabilize production, increase the morale of an organization and generally improve the quality of the product manufactured.

MARYLAND AIR CONDITIONING CORPORATION
Main Office and Works Baltimore, Maryland

Representatives in Principal Cities

KNOWLES AIR DIFFUSERS
FOR AUDITORIUM VENTILATION

Have been improved from time to time to meet the changing conditions, latest ideas and practices of Engineers, so that to-day the Knowles devices represent the highest development in the uniform diffusion of air.

SEE
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The "Tu-Way" Deflector
The "Disc-loc" Round Gallery Riser Vent.
The "Aerovalve" Steel Mushroom

The reputation of Knowles Air Diffusers has been built upon years of satisfactory service afforded from thousands of installations thruout this country and abroad. This recommendation is the reason for their continued popularity with leading Architects and Engineers.

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ESTABLISHED 1909

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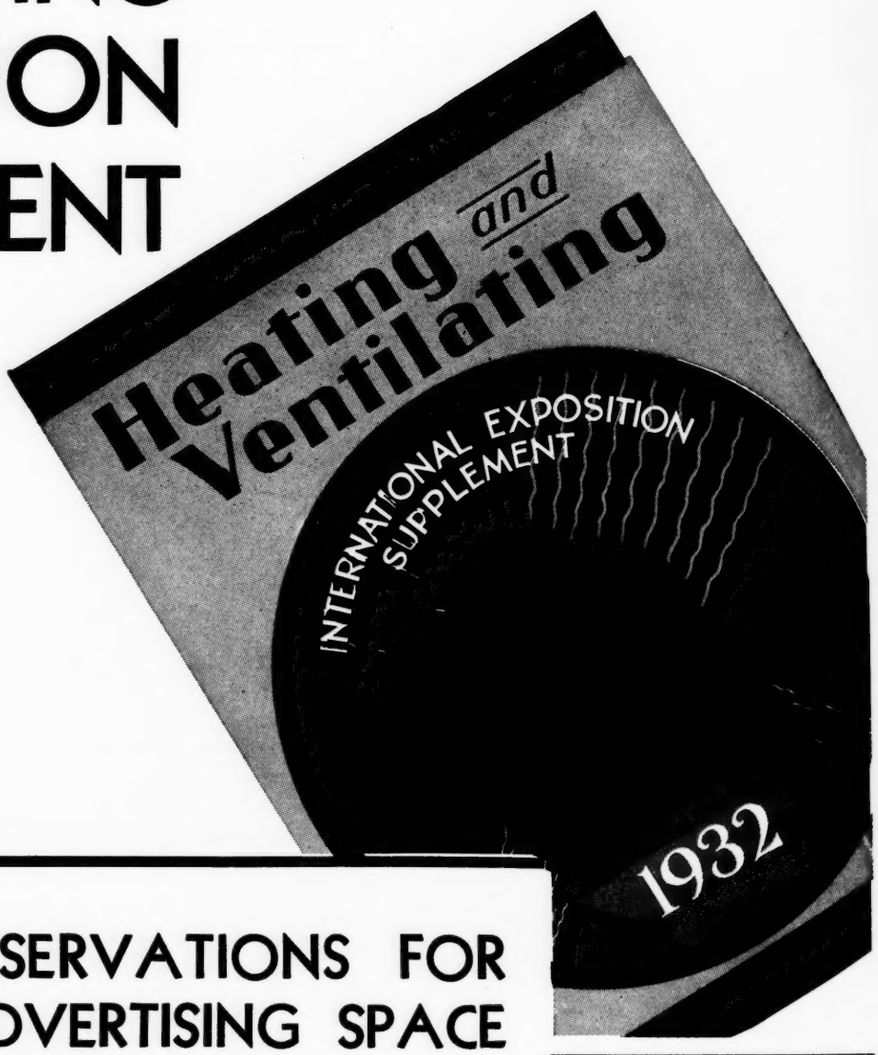

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Steel Shell Heaters

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THE SIMS COMPANY

AT ERIE, PENNA.

Quick, Easy Installation of All Wall-Hung Radiators

E-Z RADIATOR HANGERS are adjustable both horizontally and vertically for quick, easy use. The COMPLETE line for all types of hung radiators —all conditions. Write for details and prices.

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Use E-Z Lavatory Hangers

Style "C"

Also Manufacturers of E-Z INSERT

GET OUR SPECIAL QUANTITY PRICES on Janette Motorized Blowers

These ideal blowers for oil or coal-fired furnaces are almost inaudible in operation . . . rugged . . . vibrationless . . . and have high capacity. You can rely on them to give remarkably satisfactory performance.

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Real Estate Trust Bldg., Philadelphia, Pa.
Harrison Sales Co. 314 Ninth Ave. N., Seattle, Wash.
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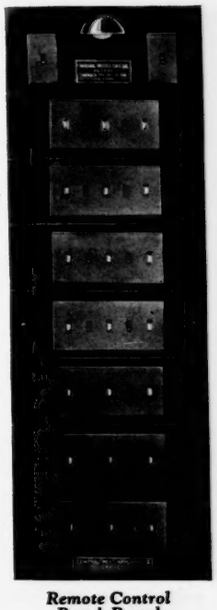
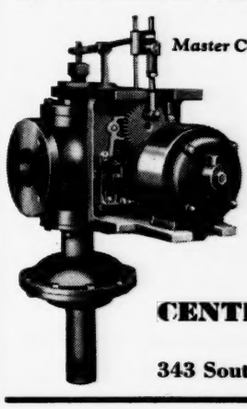
Mr. Hornung has specialized in heating control problems for over 30 years. He has developed, and patented, heating systems (Forced Circulation Hot Water) as well as controlling devices for both steam and hot water.



Remote Control Panel Board



Master Control Valve

Simplicity of design and sturdiness of construction, plus satisfactory performance and returns from investment have always been the guiding principles. We solicit your heat control problems. Let us send you our Heat Economy Bulletins.

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343 South Dearborn Street, Chicago, Illinois

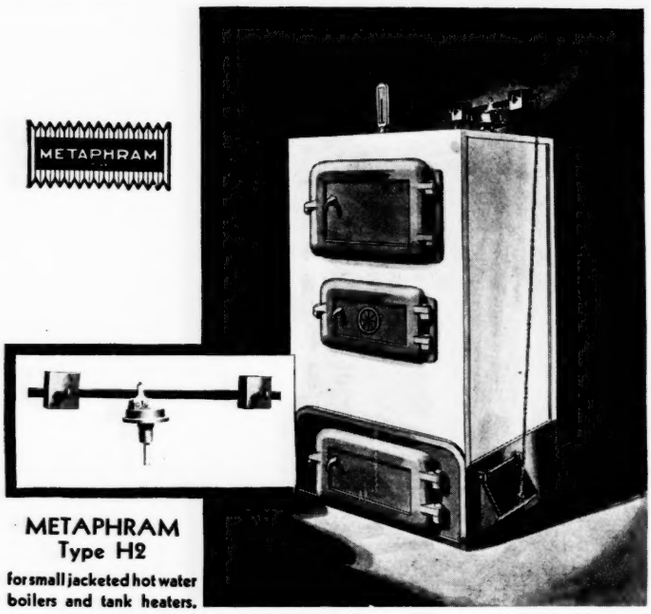
Specify **ROME**—*the best*

▲ FINNED TUBES ▲

▲ UNIT HEATERS ▲ COPPER COILS ▲

Send for engineering data

ROME-TURNEY RADIATOR COMPANY, ROME, N. Y.



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Type H2
for small jacketed hot water boilers and tank heaters.

METAPHRAM Gradual Control
covers the entire range of domestic hot water and low pressure boilers and tank heaters, either gas, oil or coal fired.

Descriptive Bulletins on Request

NATIONAL REGULATOR CO.
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Also see page 113

Pat. Pending

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BEST PROTECTION
FOR UNDERFLOOR PIPING AT
LOWEST COST

Made in No. 20, 22, 24 gauge galvanized iron and equals in strength No. 12, 14, 16 gauge uncorrugated cover.

The use of Tees, Ells and Straight lengths eliminates all cutting and fitting when installing.

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OHIO reliable MOTORS

Ohio Engineers with more than a quarter century experience in the small Motor field will gladly assist you in selecting the proper motor for your needs.

1/30 to 1 Horse Power.

THE OHIO ELECTRIC MFG. CO.
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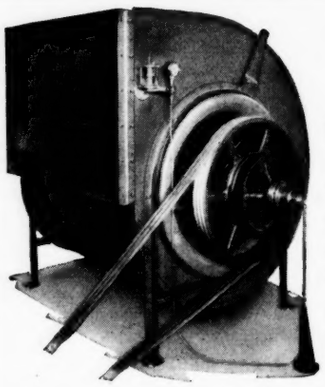

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"Can't Leak"

Hydraulic or manual controlled variable speed drive. Widely used in sound equipped theatres and public buildings. Cool and quiet at all speeds. Power saving quickly liquidates cost. One year guarantee.

HORTON MANUFACTURING CO.
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American Steam Pump Co., Battle Creek, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Janette Mfg. Co. of Chicago, Ill.
Johnson Service Co., Milwaukee, Wis.
Nash Engineering Co., So. Norwalk, Conn.
Powers Regulator Co., Chicago, Ill.

AIR CONDITIONING APPARATUS

American Air Filter Co., Louisville, Ky.
American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Greene Gas Cleaner Co., Cleveland, Ohio.
Grinnell Co., Providence, R. I.
Hartzell Propeller Fan Co., Piqua, Ohio.
Johnson Service Co., Milwaukee, Wis.
Maryland Air Conditioning Co., Baltimore, Md.
New York Blower Co., Chicago, Ill.
U. S. Ozone Corp., Scottdale, Penn.

AIR COOLING & DRYING SYSTEMS

American Air Filter Co., Louisville, Ky.
American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Clarage Fan Co., Kalamazoo, Mich.
Johnson Service Co., Milwaukee, Wis.
Maryland Air Conditioning Corp., Baltimore, Md.
Modine Mfg. Co., Racine, Wis.
National Regulator Co., Chicago, Ill.
New York Blower Co., Chicago, Ill.

AIR ELIMINATORS

Bishop & Babcock Sales Co., Cleveland, Ohio.
Marsh & Co., Jas. P., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.

AIR FILTERS

American Air Filter Co., Louisville, Ky.
American Blower Co., Detroit, Mich.
Greene Gas Cleaner Co., Cleveland, Ohio.
Staynew Filter Corp., Rochester, N. Y.

AIR SEPARATORS

Bishop & Babcock Sales Co., Cleveland, Ohio.

AIR WASHERS

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Maryland Air Conditioning Corp., Baltimore, Md.
New York Blower Co., Chicago, Ill.

BLOWERS

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Hartzell Propeller Fan Co., Piqua, Ohio.
New York Blower Co., Chicago, Ill.
Wing Mfg. Co., L. J., New York, N. Y.

BOILERS, CEMENT

Johns-Manville Corp., New York, N. Y.

BOILERS, HEATING, CAST-IRON, COAL BURNING

American Radiator Co., New York, N. Y.
Illinois Malleable Iron Co., Chicago, Ill.
Spencer Heater Co., Williamsport, Pa.
Weil-McLain Co., Chicago, Ill.

BOILERS, HEATING, DOWN-DRAFT, COAL BURNING

American Radiator Co., New York, N. Y.
Fitzgibbons Boiler Co., New York, N. Y.
Kewanee Boiler Corp., Kewanee, Ill.

BOILERS, HEATING, GAS-FIRED

American Radiator Co., New York, N. Y.

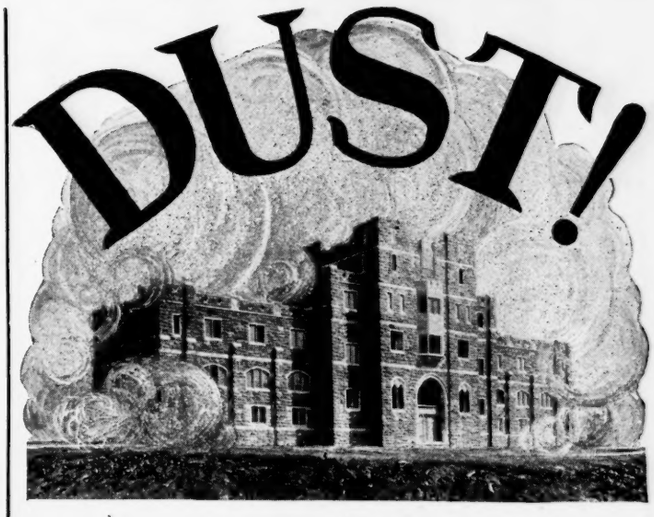
BOILERS, HEATING, OIL-FIRED

American Radiator Co., New York, N. Y.
Fitzgibbons Boiler Co., Inc., New York, N. Y.
Illinois Malleable Iron Co., Chicago, Ill.
Kewanee Boiler Corp., Kewanee, Ill.
Weil-McLain Co., Chicago, Ill.

BOILERS, HEATING, MAGAZINE FEED

Spencer Heater Co., Williamsport, Pa.

(Continued on Page 106)



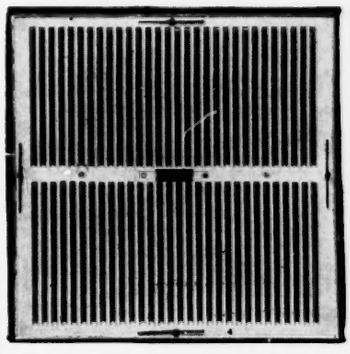
It Costs Your Clients Thousands You Could Save

Ever stop to consider your position as adviser to your clients? Most of them do not know how to plan an efficient building, so rely on you to recommend whatever will save them money.

Your clients do not know, for instance, that they could save between $1,000 and $75,000 a year (depending on size of building) in cleaning bills, redecorating and replacing furnishings and merchandise ruined by dust and soot, by installing the Protectomotor Panel Air Filter.

Nor do they know that the average person inhales more than a tablespoonful of disease-laden dust every 24 hours.

Your customers would be grateful if you explained these things and pointed out that the Protectomotor prevents 999 out of every 1,000 particles of dust in the air from getting into buildings.



The Protectomotor is a dry filter. Has no moving parts. No oil drains or cleaning tanks are needed. No extra parts required.

Simply apply a vacuum cleaner about every two months to clean. That takes about half a minute per panel.

Write for our interesting catalog

STAYNEW FILTER CORP.
15 Leighton Ave. Rochester, N.Y.

PROTECTOMOTOR
REG. U.S. PAT. OFF.
99 9/10 Per Cent EFFICIENT
AIR FILTERS

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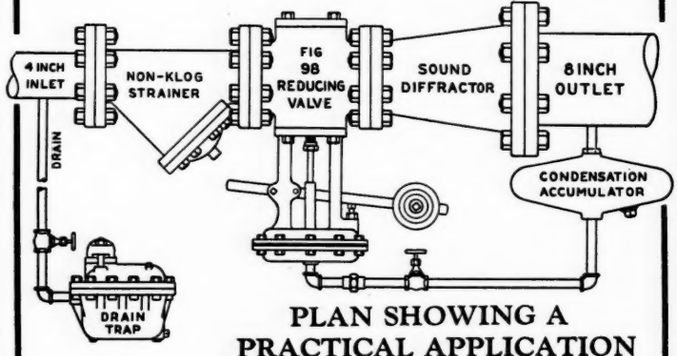
Silence is essential to the operation of

HEATING SYSTEMS in

Schools, Hospitals, Theaters

Noise—Nuisance Problems Solved

BOYLSTON SOUND DIFFRACTOR is a device for preventing the transmission of sound waves produced by steam after it has passed through the Pressure Reducing Valve.



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Send for booklet.

Boylston Steam Specialty Co.

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Kewanee Boiler Corp., Kewanee, Ill.
Spencer Heater Co., Williamsport, Pa.

BOILERS, POWER

Fitzgibbons Boiler Co., Inc., New York, N. Y.

CIRCULATORS, WATER

Janette Mfg. Co., Chicago, Ill.
H. A. Thrush & Co., Peru, Ind.

COILS, PIPE

Clarage Fan Co., Kalamazoo, Mich.
Crane Co., Chicago, Ill.
Whitlock Coil Pipe Co., Hartford, Conn.

CONDENSERS

Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
National Pipe Bending Co., New Haven, Conn.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.
Wolverine Tube Co., Detroit, Mich.

CONDUITS, UNDERGROUND PIPE

Johns-Manville Corp., New York, N. Y.
Ric-wiL Co., The, Cleveland, Ohio.

CONVERTERS, HOT WATER

Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
National Pipe Bending Co., New Haven, Conn.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.

COOLERS, AIR

Alberger Heater Co., Buffalo, N. Y.
Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
Maryland Air Conditioning Corp., Baltimore, Md.
National Pipe Bending Co., New Haven, Conn.

COOLERS, OIL

National Pipe Bending Co., New Haven, Conn.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.

COOLING TOWERS, PONDS AND SPRAY COOLING SYSTEMS

Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Ross Heater & Mfg. Co., Buffalo, N. Y.

COVERING, BOILER, PIPE, ETC.

Crane Co., Chicago, Ill.
General Insulating & Mfg. Co., Alexandria, Ind.
Johns-Manville Corp., New York, N. Y.
Ric-wiL Co., The, Cleveland, Ohio.
Wyckoff & Son, A., Elmira, N. Y.

DAMPER REGULATORS

(See Regulators, Damper)

DAMPERS, DUCT

Barber-Colman Co., Rockford, Ill.
National Regulator Co., Chicago, Ill.

DEHUMIDIFYING APPARATUS

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Johnson Service Co., Milwaukee, Wis.
Maryland Air Conditioning Corp., Baltimore, Md.
New York Blower Co., Chicago, Ill.
Wing Mfg. Co., L. J., New York, N. Y.

DISTILLERS (WATER)

Ross Heater & Mfg. Co., Buffalo, N. Y.

DRAFT APPLIANCES, MECHANICAL

American Blower Co., Detroit, Mich.
Clarage Fan Co., Kalamazoo, Mich.
National Regulator Co., Chicago, Ill.
New York Blower Co., Chicago, Ill.
Wing Mfg. Co., L. J., New York, N. Y.

DRYING SYSTEMS

(See Air Cooling & Drying (Systems)

DUST COLLECTING SYSTEMS

American Air Filter Co., Louisville, Ky.
American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.

ENGINES, STEAM

American Blower Co., Detroit, Mich.
Clarage Fan Co., Kalamazoo, Mich.

EVAPORATORS, BOILER FEED MAKE-UP

Ross Heater & Mfg. Co., Buffalo, N. Y.

ENGINEERS' SPECIFICATION INDEX

EXHAUST HEADS

Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.

EXHAUST FANS & SYSTEMS

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Hartzell Propeller Fan Co., Piqua, Ohio.
Torrington Mfg. Co., Torrington, Conn.
Wing Mfg. Co., L. J., New York, N. Y.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N. Y.
Badger & Sons Co., E. B., Boston, Mass.
Central Station Steam Co., Detroit, Mich.
Crane Co., Chicago, Ill.
Fulton Sylphon Co., Knoxville, Tenn.
Hornung, J. C., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Webster & Co., Warren, Camden, N. J.

EXPANSION SHELLS

Phillips Drill Co., Chicago, Ill.

FANS, CENTRIFUGAL

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
New York Blower Co., Chicago, Ill.
Torrington Mfg. Co., Torrington, Conn.
Wing Mfg. Co., L. J., New York, N. Y.

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American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
New York Blower Co., Chicago, Ill.
Torrington Mfg. Co., Torrington, Conn.
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American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Hartzell Propeller Fan Co., Piqua, Ohio.
New York Blower Co., Chicago, Ill.
Torrington Mfg Co., Torrington, Conn.
Wing Mfg Co., L. J., New York, N. Y.

FANS, PROPELLER

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Emerson Electric Mfg. Co., St. Louis, Mo.
Hartzell Propeller Fan Co., Piqua, Ohio.
Modine Mfg. Co., Racine, Wis.
New York Blower Co., Chicago, Ill.
Wing Mfg. Co., L. J., New York, N. Y.

FANS, STEEL PLATE

American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
New York Blower Co., Chicago, Ill.

FEEDERS, BOILER

Kieley & Mueller, Inc., New York, N. Y.
McDonnell & Miller, Chicago, Ill.
Watts Regulator Co., Lawrence, Mass.
Webster & Co., Warren, Camden, N. J.

FEEDERS, WATER, STEAM BOILER

Kieley & Mueller, Inc., New York, N. Y.
McDonnell & Miller, Chicago, Ill.

FITTINGS, ACID RESISTING

Crane Co., Chicago, Ill.

FITTINGS, PIPE

Crane Co., Chicago, Ill.
Grinnell Co., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.

FITTINGS, PIPE, FABRICATED

Tube-Turns, Inc., Louisville, Ky.

GASKETS

Crane Co., Chicago, Ill.
Johns-Manville Corp., New York, N. Y.
McCord Radiator & Mfg. Co., Detroit, Mich.

GAUGE BOARDS

Bishop & Babcock Sales Co., Cleveland, Ohio.
Marsh & Co., Jas. P., Chicago, Ill.

GAUGE GLASSES

Crane Co., Chicago, Ill.

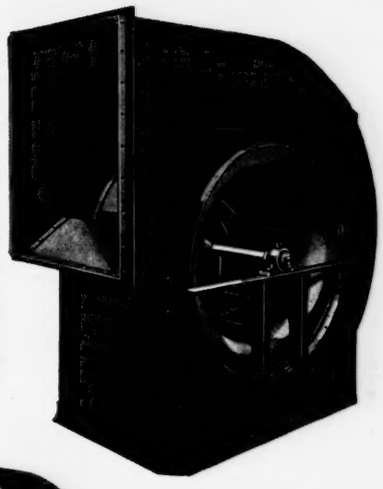
GAUGES, ALTITUDE

American Radiator Co., New York, N. Y.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.

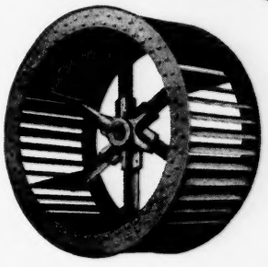
GAUGES, COMBINATION PRESSURE AND ALTITUDE

Marsh, Jas. P., Chicago, Ill.
Mercoid Corp., Chicago, Ill.
H. A. Thrush & Co., Peru, Ind.

(Continued on Page 108)



Right—Streamline Fan . . . extremely quiet operation at high speed . . direct connection to standard motors . . . non-overloading horsepower characteristic . . . continuously rising pressure characteristic . . . practically linear pressure curve . . . high efficiency over a wide range . . . economical to operate.



Left—Squirrel Cage Fan Wheel . . perfect balance prevents deflection, distortion or vibration at high speed—heavy spider, on which wheel is built, is ideal construction for rigidity, strength and balance.

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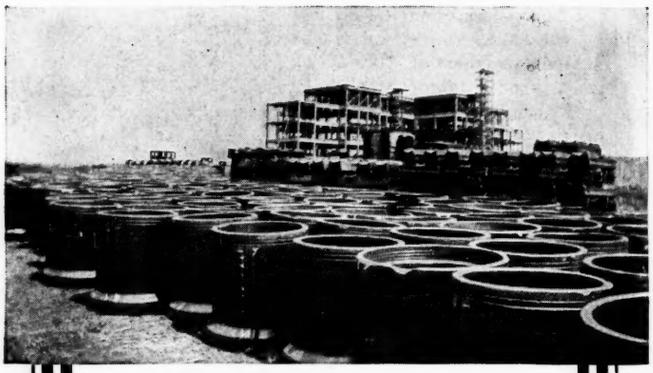
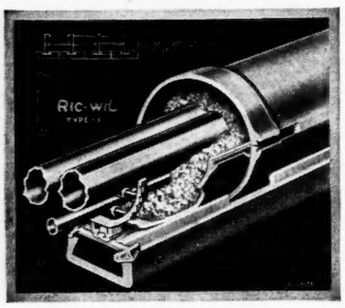


1300 MILES

THIS un-retouched photograph shows part of a Ric-wiL shipment ready to be installed after being shipped more than 1300 miles. It shows the perfect condition in which Ric-wiL materials land on the job 99 times out of 100 . . . whether shipped a few miles or across the country. It's picture proof of our shipping records which show a breakage of only about one-fourth of one percent.

The completeness of Ric-wiL Systems . . . the elimination of extras . . . the absence of delays, special field construction and engineering . . . the simplicity of Ric-wiL construction . . . all combine to make Ric-wiL Conduit Systems outstandingly low in installation costs.



Ric-wiL Type F Conduit Systems with Dry-paC Waterproof Insulation, insure the highest possible efficiency for underground heating or power pipes. 90% efficiency is guaranteed for this System . . . tests of actual installations show efficiencies up to 95.6%.

Each part of a Ric-wiL System "interlox" with the others to form a compact rigid whole. Sections of the Base Drain stagger with the conduit sections. Pipe supports wedge between sections of Base Drain, resting on Base Drain side shoulders, and extend thru special holes into the conduit to carry the pipes. Top and bottom conduit halves are locked together with the water-tight Loc-liP Side Joint. Ric-wiL Systems are permanent . . . they "stay put".

Ric-wiL Engineers will assist with or furnish plans . . . also supervise installations if desired. Write for Bulletin C-3101 showing photographs of a Ric-wiL multiple pipe installation, using new Base Drain with side shoulders.

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GAUGES, HYDRAULIC

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Mercoid Corporation, Chicago, Ill.

GAUGES, PRESSURE

American Radiator Co., New York, N. Y.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

GAUGES, VACUUM

American Radiator Co., New York, N. Y.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.
Webster & Co., Warren, Camden, N. J.

GAUGES, VACUUM (COMPOUND)

Bishop & Babcock Sales Co., Cleveland, Ohio.
Illinois Engineering Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.
Webster & Co., Warren, Camden, N. J.

GAUGES, VOLUME

Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

GAUGES, WATER

Crane Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.

GENERATOR COOLING SYSTEMS

American Air Filter Co., Louisville, Ky.
American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.

GOVERNORS (PUMP)

Bishop & Babcock Sales Co., Cleveland, Ohio.
Crane Co., Chicago, Ill.
Kieley & Mueller, Inc., New York, N. Y.
Marsh & Co., Jas. P., Chicago, Ill.
Watts Regulator Co., Lawrence, Mass.
Webster & Co., Warren, Camden, N. J.

GRATES—ALL TYPES

Fitzgibbons Boiler Co., Inc., New York, N. Y.
Kewanee Boiler Corp., Kewanee, Ill.

HEAT CABINETS

(See Radiators, Cabinet and Concealed)

HEATERS, AIR, FAN SYSTEM

Aerofin Corp., Newark, N. J.
American Blower Co., Detroit, Mich.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
Modine Mfg. Co., Racine, Wis.
New York Blower Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Wing Mfg. Co., L. J., New York, N. Y.

HEATERS, DOMESTIC WATER

Alberger Heater Co., Buffalo, N. Y.
American Radiator Co., New York, N. Y.
Crane Co., Chicago, Ill.
Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
Illinois Malleable Iron Co., Chicago, Ill.
Kewanee Boiler Corp., Kewanee,, Ill.
Modine Mfg. Co., Racine, Wis.
National Pipe Bending Co., New Haven, Conn.
Patterson-Kelley Co., New York, N. Y.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Sims Co., Erie, Pa.
Spencer Heater Co., Williamsport, Pa.
Weil-McLain Co.. Chicago, Ill.
Whitlock Coil Pipe Co., Hartford, Conn.

HEATERS, FEED WATER

Alberger Heater Co., Buffalo, N. Y.
Frank Heater & Engineer Co., O. E., Buffalo, N. Y.
Illinois Malleable Iron Co., Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Patterson-Kelley Co., New York, N. Y.
Ross Heater & Mfg Co., Buffalo, N. Y.
Sims Co., Erie, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

HEATERS, FUEL-OIL

Alberger Heater Co., Buffalo, N. Y.
Frank Heater & Engineering Co., O. E., Buffalo, N. Y.
National Pipe Bending Co., New Haven, Conn.
Patterson-Kelley Co., New York, N. Y.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.

ENGINEERS' SPECIFICATION INDEX

HEATERS, TANK, AUTOMATIC

National Pipe Bending Co., New Haven, Conn.

HEATERS, UNIT

Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.
McCord Radiator & Mfg. Co., Detroit, Mich.
Modine Mfg. Co., Racine, Wis.
Nelson Corp., Herman, The, Moline, Ill.
New York Blower Co., Chicago, Ill.
Torrington Mfg. Co., Torrington, Conn.
Wing Mfg. Co., L. J., New York, N. Y.
Wolverine Tube Co., Detroit, Mich.

HEATING SYSTEMS, VACUUM

Bishop & Babcock Sales Co., Cleveland, Ohio.
Illinois Engineering Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.
Webster & Co., Warren, Camden, N. J.

HEATING SYSTEMS, VAPOR

Bishop & Babcock Sales Co., Cleveland, O.
Illinois Engineering Co., Chicago, Ill.
Marsh & Co., Jas. P., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.
Webster & Co., Warren, Camden, N. J.

HEATING SYSTEMS, WATER

American Radiator Co., New York, N. Y.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Grinnell Co., Providence, R. I.
Hornung, J. C., Chicago, Ill.
Ross Heater & Mfg. Co., Buffalo, N. Y.
H. A. Thrush & Co., Peru, Ind.

HUMIDIFIERS

American Air Filter Co., Louisville, Ky.
Bishop & Babcock Sales Co., Cleveland, Ohio
Grinnell Co., Providence, R. I.
Johnson Service Co., Milwaukee, Wis.
Maryland Air Conditioning Corp., Baltimore, Md.
National Regulator Co., Chicago, Ill.
Torrington Mfg. Co., Torrington, Conn.

HUMIDITY CONTROL

American Air Filter Co., Louisville, Ky.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Grinnell Co., Providence, R. I.
Johnson Service Co., Milwaukee, Wis.
National Regulator Co., Chicago, Ill.
Powers Regulator Co., Chicago, Ill.

INSTRUMENTS, INDICATING AND RECORDING

Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.

INSULATION, BOILER, PIPE, ETC.

(See Covering, Boiler, Pipe, etc.)

INSULATION, BUILDING

Celotex Co., Chicago, Ill.
General Insulating & Mfg. Co., Alexandria, Ind.
Insulite Co., Minneapolis, Minn.
Johns-Manville Corp., New York, N. Y.

MECHANICAL DRAFT APPLIANCES

(See Draft Appliances, Mechanical)

METAL, SHEET

American Rolling Mill Co., Middletown, Ohio.
American Sheet & Tin Plate Co., Pittsburgh, Pa.

METALS, THERMOSTATIC

Chace Valve Co., W. M., Detroit, Mich.

METERS, CONDENSATION

Central Station Steam Co., Detroit, Mich.

METERS, FEED WATER

Central Station Steam Co., Detroit, Mich.

METERS, WATER, GAS, OIL AND AIR

Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

MOTORS (ELECTRIC)

Baldor Electric Co., St. Louis, Mo.
Century Electric Co., St. Louis, Mo.
Emerson Electric Mfg. Co., St. Louis, Mo.
Imperial Electric Co., Akron, O.
Janette Mfg. Co., Chicago, Ill.
Ohio Electric Mfg. Co., Cleveland, Ohio.

NOZZLES, SPRAY

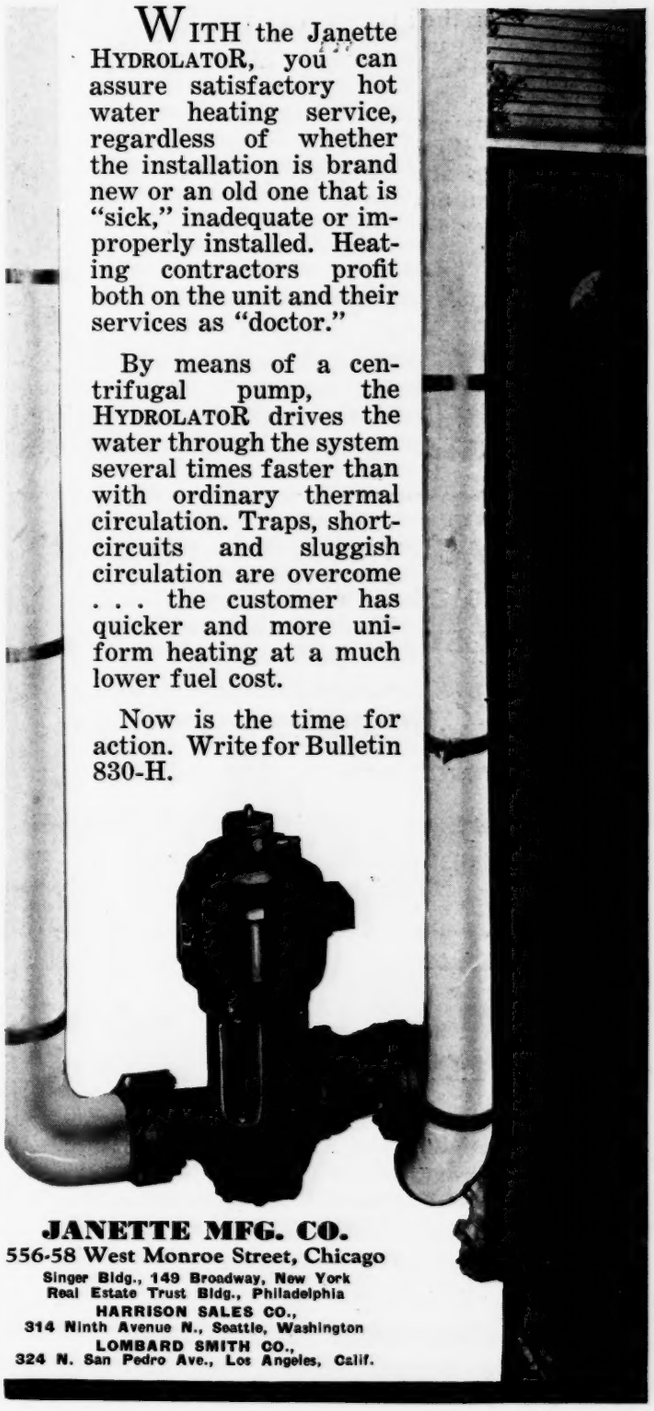
Bishop & Babcock Sales Co., Cleveland, Ohio.
Clarage Fan Co., Kalamazoo, Mich.

OIL BURNERS

Electrol, Inc., New York, N. Y.
Petroleum Heat & Power Co., Stamford, Conn.
Silent Automatic Corp., Detroit, Mich.

(Continued on Page 110)

Speed Up Both BUSINESS AND HOT WATER CIRCULATION with the HYDROLATOR



WITH the Janette HYDROLATOR, you can assure satisfactory hot water heating service, regardless of whether the installation is brand new or an old one that is "sick," inadequate or improperly installed. Heating contractors profit both on the unit and their services as "doctor."

By means of a centrifugal pump, the HYDROLATOR drives the water through the system several times faster than with ordinary thermal circulation. Traps, short-circuits and sluggish circulation are overcome . . . the customer has quicker and more uniform heating at a much lower fuel cost.

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Hornung, J. C., Chicago, Ill.
Janette Mfg. Co., Chicago, Ill.

OIL BURNER IGNITION AND CONTROL EQUIPMENT

McDonnell & Miller, Chicago, Ill.
Mercoid Corporation, Chicago, Ill.
Penn Electric Switch Co., Des Moines, Iowa.
Penn Heat Control Co., Philadelphia, Pa.
White Mfg. Co., St. Paul, Minn.

OZONE APPARATUS

United States Ozone Co. of America, Scottdale, Pa.

PIPE BENDING

Badger & Sons Co., E. B., Boston, Mass.
Crane Co., Chicago, Ill.
Grinnell Co., Providence, R. I.
National Pipe Bending Co., New Haven, Conn.
Whitlock Coil Pipe Co., Hartford, Conn.

PIPE, CAST-IRON

American Radiator Co., New York, N. Y.

PIPE FITTINGS FOR WELDING

Tube-Turns, Inc., Louisville, Ky.

PIPE HANGERS

Crane Co., Chicago, Ill.
Grinnell Co., Providence, R. I.

PIPE THREADING AND CUTTING MACHINES

Crane Co., Chicago, Ill.

PIPE, STEEL

Crane Co., Chicago, Ill.
National Tube Co., Pittsburgh, Pa.

PRESSURE REDUCING VALVES

(See Regulators, Pressure)

PUMPS, CENTRIFUGAL, VACUUM HEATING

American Steam Pump Co., Battle Creek, Mich.
Ames Pump Co., New York, N. Y.
Nash Engineering Co., So. Norwalk, Conn.
Skidmore Corp., St. Joseph, Mich.

PUMPS, CONDENSATION

American Steam Pump Co., Battle Creek, Mich.
Ames Pump Co., New York, N. Y.
Nash Engineering Co., So. Norwalk, Conn.
Skidmore Corp., St. Joseph, Mich.

PUMPS, OIL

Janette Mfg. Co., Chicago, Ill.

PUMPS, SUMP

American Steam Pump Co., Battle Creek, Mich.
Janette Mfg. Co., Chicago, Ill.
Nash Engineering Co., So. Norwalk, Conn.

PUMPS, TURBINE

Ames Pump Co., New York, N. Y.
Nash Engineering Co., So. Norwalk, Conn.

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American Radiator Co., New York, N. Y.
McCord Radiator & Mfg. Co., Detroit, Mich.
The Herman Nelson Corp., Moline, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Wolverine Tube Co., Detroit, Mich.

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American Radiator Co., New York, N. Y.
Grinnell Co., Providence, R. I.
Hartmann Co., Charles, Brooklyn, N. Y.
Healy-Ruff Co., St. Paul, Minn.
Kewanee Boiler Corp., Kewanee, Ill.
Universal Sales Co., Rochester, N. Y.

RADIATORS, CABINET AND CONCEALED

Modine Mfg. Co., Racine, Wis.
Nelson Corp., Herman, The, Moline, Ill.

RADIATORS, CAST-IRON

American Radiator Co., New York, N. Y.
Kewanee Boiler Corp., Kewanee, Ill.
Modine Mfg. Co., Racine, Wis.
Nelson, Corp., Herman, The, Moline, Ill.

RADIATORS, GAS-FIRED

American Radiator Co., New York, N. Y.

RADIATORS, VERTICAL FIN

Wolverine Tube Co., Detroit, Mich.

RECEIVERS, AIR

Whitlock Coil Pipe Co., Hartford, Conn.

RECEIVERS, CONDENSATION

Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Whitlock Coil Pipe Co., Hartford, Conn.

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Kieley & Mueller, Inc., New York.
McDonnell & Miller, Chicago, Ill.

REGULATORS, DAMPER

American Radiator Co., New York, N. Y.
Barber-Colman Co., Rockford, Ill.
Fulton Sylphon Co., Knoxville, Tenn.
Hoffman Specialty Co., New York, N. Y.
Illinois Engineering Co., Chicago, Ill.
Johnson Service Co., Milwaukee, Wis.

ENGINEERS' SPECIFICATION INDEX

Kieley & Mueller, Inc., New York.
Marsh & Co., Jas. P., Chicago, Ill.
National Regulator Co., Chicago, Ill.
Powers Regulator Co., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.
H. A. Thrush & Co., Peru, Ind.
White Mfg. Co., St. Paul, Minn.

REGULATORS, GAS

Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

REGULATORS, PRESSURE

Bishop & Babcock Sales Co., Cleveland, Ohio.
Crane Co., Chicago, Ill.
Hornung, J. C., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Johnson Service Co., Milwaukee, Wis.
Kieley & Mueller, Inc., New York, N. Y.
Lytton Mfg. Corp., Franklin, Va.
Marsh & Co., Jas. P., Chicago, Ill.
National Regulator Co., Chicago, Ill.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Powers Regulator Co., Chicago, Ill.
H. A. Thrush & Co., Peru, Ind.

REGULATORS, TEMPERATURE

(See Temperature Control)

REGULATOR, WATER

Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

SEPARATORS, OIL

Bishop & Babcock Sales Co., Cleveland, Ohio.
Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
National Pipe Bending Co., New Haven Conn.
Patterson-Kelley Co., New York, N. Y.
Webster & Co., Warren, Camden, N. J.

SEPARATORS, STEAM

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Crane Co., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Sims Co., Erie, Pa.
Webster & Co., Warren, Camden, N. J.

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American Rolling Mill Co., Middletown, Ohio.
American Sheet & Tin Plate Co., Pittsburgh, Pa.

SOUND PREVENTION

Boylston Steam Specialty Co., Chicago, Ill.

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(See Nozzles, Spray)

STERILIZER, WATER

U. S. Ozone Corp., Scottdale, Penn.

STOKERS, GRAVITY FEED

Spencer Heater Co., Williamsport, Pa.

STOKERS, MECHANICAL

Crosley Radio Corp., Cincinnati, Ohio.
Detroit Stoker Co., Detroit, Mich.

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Bishop & Babcock Sales Co., Cleveland, Ohio.
Illinois Engineering Co., Chicago, Ill.
Janette Mfg. Co., Chicago, Ill.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Sarco Co., Inc., New York, N. Y.

STRAINERS, STEAM

Bishop & Babcock Sales Co., Cleveland, Ohio.
Illinois Engineering Co., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.

STRAINERS, WATER

Illinois Engineering Co., Chicago, Ill.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Ross Heater & Mfg. Co., Buffalo, N. Y.
Sarco Co., Inc., New York, N. Y.
H. A. Thrush & Co., Peru, Ind.

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Badger & Sons Co., E. B., Boston, Mass.

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Barber-Colman Co., Rockford, Ill.
Bishop & Babcock Sales Co., Cleveland, Ohio.
Fulton Sylphon Co., Knoxville, Tenn.
Hornung, J. C., Chicago, Ill.
Illinois Engineering Co., Chicago, Ill.
Johnson Service Co., Milwaukee, Wis.
Kieley & Mueller, Inc., New York, N. Y.
Marsh & Co., Jas. P., Chicago, Ill.
Mercoid Corporation, Chicago, Ill.
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Powers Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Iowa.
Raymond, F. I., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.
H. A. Thrush & Co., Peru, Ind.
White Mfg. Co., St. Paul, Minn.

THERMOMETERS, RECORDING AND INDICATING

American Radiator Co., New York, N. Y.
Marsh & Co., Jas. P., Chicago, Ill.
Powers Regulator Co., Chicago, Ill.
Sarco Co., Inc., New York, N. Y.
Standard Thermometer, Inc. Boston, Mass.

THERMOSTATIC METAL

W. M. Chace Valve Co., Detroit, Mich.

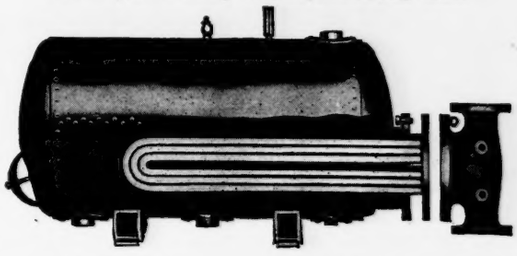
(Continued on Page 112)

NATIONAL

Red Head

STORAGE HEATERS

For Industrial Plants, Laundries, Apartments, Schools, Clubs, Hotels, Etc.



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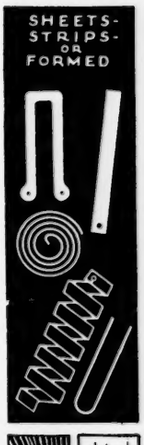
CHACE THERMOSTATIC BIMETAL

"It Bends With the Heat"



Many oil burner manufacturers have chosen Chace Thermostatic Bimetal because of its high sensitivity, accuracy, uniformity and reliability. 1200 degrees Fahrenheit without distortion. Obtainable in sheets, strips or formed to meet your requirements; assured automatic action at definitely predetermined temperature. Consult our Engineering Department.

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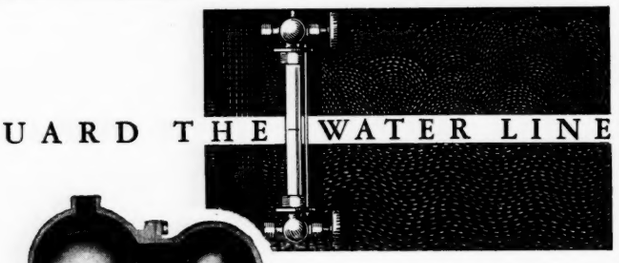

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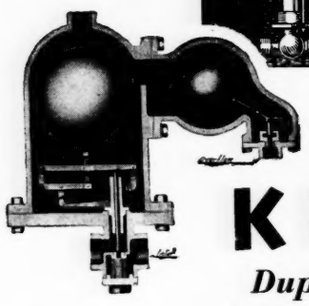

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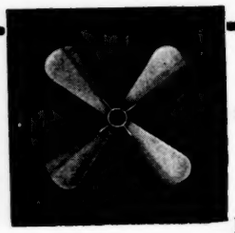

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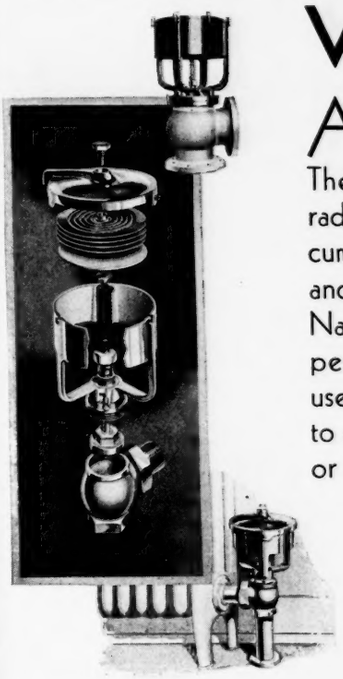

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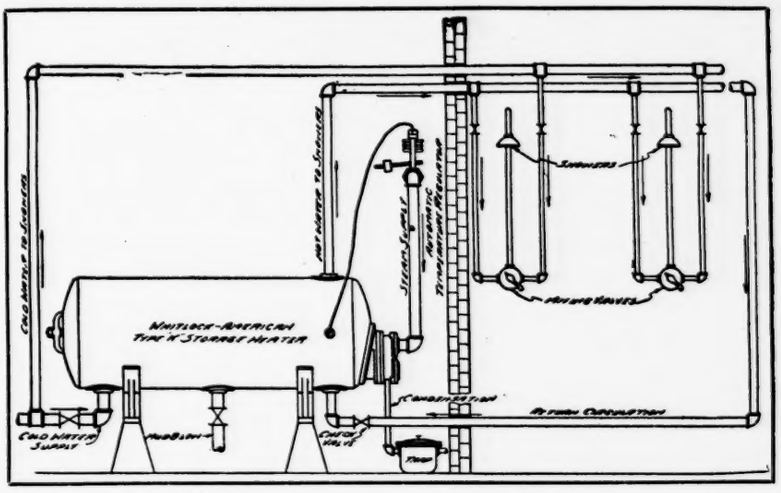

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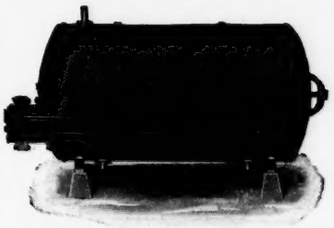

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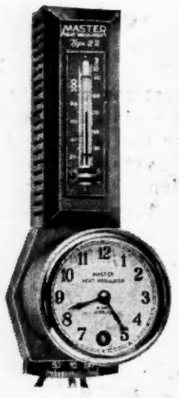

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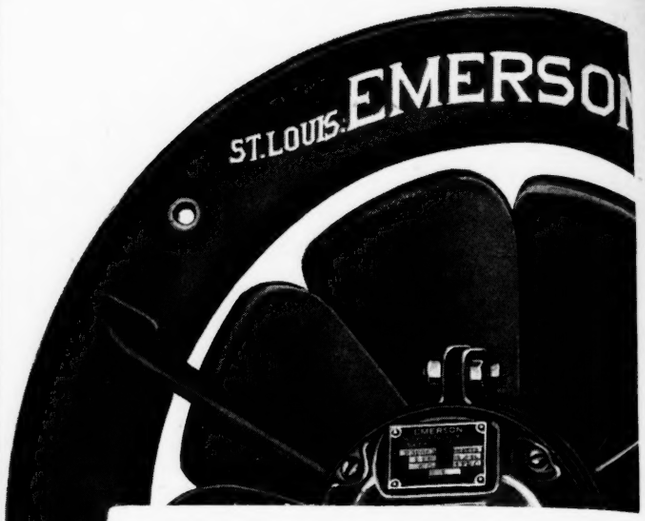

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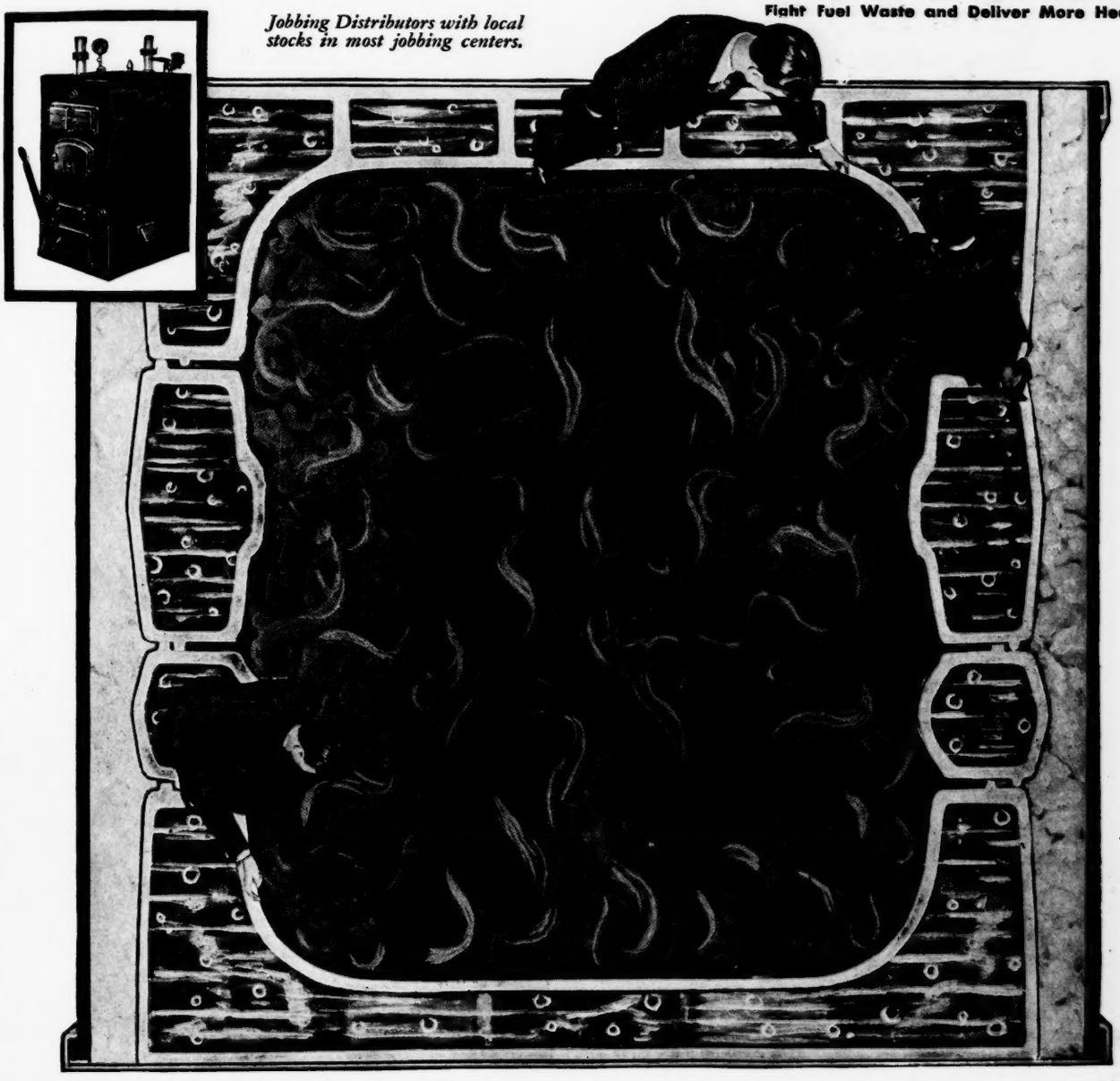

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